SUPPLY RESPONSES AMONG SMALL HOLDER PRODUCERS OF ARABICA AND ROBUSTA COFFEE IN CAMEROON

By

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A DISSERTATION PRESENTED TO THE GRADUATE SCHOOL
OF THE UNIVERSITY OF FLORIDA IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

UNIVERSITY OF FLORIDA

1994

ACKNOWLEDGMENTS

I am indebted to Dr. Robert Emerson for his thoughtful guidance throughout this endeavor, to Dr. Max Langham for his many trenchant insights, and to Dr. Uma Lele for expanding my view of development economics. The efforts of Dr. Christina Gladwin and Dr. Lawrence Kenny in serving on the committee are gratefully acknowledged. I would like to thank International Programs in the Institute of Food and Agricultural Science for providing a portion of the funding used to carry out the research. The dissertation would not have been completed without the support received from the Department of Agricultural Economics at the University of Dschang as well as the Agricultural Education Project of USAID in Dschang. In particular, I would like to thank Dr. François Kamajou, Dr. Peter Hartmann, Dr. Ayissi Mballa, Dr. Nkwain Sama and Mr. Emmanuel Foko for sharing their knowledge of Cameroon in numerous discussions.

To my wife Suzanne Tchoumta, without whom I could not have arrived at this point, there are not words to express my gratitude and love. Finally, I would like to acknowledge the smiles, kisses and hugs of my daughter, Camille, which have never failed to reinvigorate my efforts.

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Abstract of Dissertation Presented to the Graduate School of the University of Florida in Partial Fulfillment of the Requirements for the Degree of Doctor of Philosophy

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December 1994

Chairman: Robert D. Emerson
Major Department: Food and Resource Economics

The estimation of perennial supply response is typically constrained by a lack of aggregate data on key investment variables. An alternative microeconometric approach, capturing the heterogeneous supply response of individual farmers, was developed. The structural relationships underlying producer supply response were estimated with fixed effects Tobit models of new planting, replanting, and fertilizer demand and a fixed effects model of short-run response. Dynamic vintage capital effects were incorporated through empirical age-yield profiles. The age-yield profiles were used to construct producer expectations of gross discounted revenues of a coffee tree and in conjunction with the tree age distribution to provide a measure of feasible production for each farm.

The models were estimated using panel data obtained from the cooperative and marketing board production records of 500 producers surveyed in 1992 in the four major producing provinces. The mean

elasticity of new plantings with respect to expected gross revenues was nearly twice as large among robusta (*Coffea canephora*) producers as among arabica (*Coffea arabica*) producers. In contrast, arabica producers were more responsive in their replanting behavior. Output simulations were conducted for the mean producer of both types of coffee using the estimated structural parameters. The immediate run supply elasticities were .350 and .429 for robusta and arabica, respectively; after ten years they were .856 and .629. *Ex ante*, varietal improvements would elicit a higher output response over time in the robusta sector. Farm-specific variables having significant effects on the structural relations included producer age and education, total farm hectares, family size, capital stock and access to input markets. Significant regional variation in supply response was also noted.

The quantitative evaluation of current price reforms in a sectoral model of coffee exports indicated that shifting from a monopsonistic to a competitive regime would significantly increase the elasticities of export quantities, producer price, and marketing margins with respect to changes in border prices.

Information on heterogeneous supply response is valuable to policy makers in their decision making. Differentiated regional strategies incorporating various mixes of price incentives, yield innovations and public good investments are indicated based on the empirical results of the study.

CHAPTER 1
INTRODUCTION

A reliance on primary agricultural commodity production characterizes many economies in the early stages of development, and so commodity production generates a significant share of foreign exchange earnings, labor employment and government revenues. The focus of this study is the coffee industry in Cameroon, West Africa. In particular, microeconometric models of supply and fertilizer demand were estimated for robusta and arabica producers from the four major coffee producing provinces. The supply response parameter estimates were used in a sectoral model of coffee exports to evaluate the change from a monopsonistic pricing regime administered by the national marketing board towards a more liberal pricing regime.

In this chapter, the problems addressed in the rest of the study and their contexts are discussed. First, an historical perspective is given.

Coffee in Cameroon's Economy

European trade in primary commodities began to develop on a significant commercial scale in the 16th century. The first shipment of slave-grown West Indian sugar arrived in Spain in the year 1515, establishing the infamous triangular trade among Africa, America, and Europe whose profits led in large measure to the commercial supremacy of France and England in the 18th century (Davidson, 1961; North, 1961). Coffee did not become a popular drink in Europe until the 17th century,

and its rather limited demand was at the time almost entirely obtained from Yemen. Coffee production in the French colonial territories of Africa began in the 20th century. Total coffee exports in the French colonies grew from an average annual level of 240 metric tons in the 5 years prior to WWI to over 75,000 tons by 1949.

Commercial coffee production in Cameroon for export to the European market was first undertaken in the early 20th century by a few German colonial settlers, growing the indigenous robusta species (*Coffea canephora*) on the fertile lower slopes and foothills of Mount Cameroon, an active volcano with the highest elevation in West Africa. The industry grew slowly in its early years, counting only 100 hectares of plantation by the outbreak of WWI in 1914 (Epale, 1985). The establishment of seedling nurseries in Nkongsamba and Dschang in 1923 and 1924 by the French colonial authorities was one of the important first steps in building the robusta and arabica coffee industries in the Littoral and West Provinces. These provinces, from the inception of the industry, have remained the largest producers of arabica and robusta coffee in Cameroon.

Myint (1965), examining European imperialist expansions into India, Africa, and Asia, notes that the introduction of manufactured goods often created wants among indigenous populations that led to the autonomous adoption of primary commodity production. Jean-Marie Dongmo's (pp. 126-151, 1981) description of the adoption of arabica coffee in the 1930s by Bamiléké planters in the area surrounding Dschang agrees with Myint's observations. Their enthusiasm was so great that the colonial authorities, overtly concerned about an adequate land reserve for food production,

while covertly responding to concerns raised by French planters over the maintenance of quality on the world market, deemed it necessary to regulate the planting of coffee by Cameroonians. On July 4, 1933, a law was passed requiring colonial authorization before a Cameroonian could create a plantation. Authorization was granted only after the proposed site had been inspected and determined suitable.[1] On September 9, 1935, the strict maintenance of a coffee plantation was mandated.

At present, most of the coffee in Cameroon is produced by family farms on small holdings. Revenues from coffee form a major portion of these households' income (Dongmo, 1981; Kamajou and Nkwanou, 1985; Fouda, 1988). There are two major commercial species of coffee grown, arabica (*Coffea arabica* L.), and robusta. Because of agro-ecological requirements, arabica is found almost exclusively in the highlands of the West and Northwest provinces and robusta at lower elevations in the Littoral, West, East and Southwest provinces. While both varieties are highly labor intensive as produced in Cameroon, arabica requires more on-farm processing after harvesting and also more chemical pesticides because of a higher incidence of pest problems. Robusta is the higher yielding of the two varieties.

Of the two types of coffee, arabica was the first to become economically important to small holders. By 1941 there were approximately 1,700 "authorized" Cameroonians producing arabica coffee in the West province on farms typically consisting of fewer than 1,000 trees (< 1 hectare in area). Following WWII as the struggle for independence grew,

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[1] Planters were authorized a fixed number of trees; if they exceeded this number the trees were uprooted. Similarly, if the plantation was not regularly weeded, the trees could be uprooted.

coffee growers increasingly chose to ignore the authorization requirement imposed in the 1930s. This civil disobedience was encouraged by KUMZE, a nationalist political party created by Mathias Djomessi a traditional ruler of Forèké-Dschang in the West Province.[2] In an attempt to appease the population, the colonial authorities did not act against those creating unauthorized plantations. By 1955, all of the controls on coffee production had been lifted. This, along with remunerative prices in the mid-1950s, resulted in a rapid expansion of arabica tree plantings over the latter half of the 1950s. Arabica production grew steadily in the 1960s, peaking in the 1970s, and since then declining gradually (Figure 1). Arabica grown at high altitudes has a mild flavor, especially when "washed", that is more preferred by coffee drinkers; for this, a premium ranging from 10 to 40 percent above the robusta price is normally paid on the world market.[3]

The expansion of the robusta sector in the 1960s and 1970s was rapid. Average annual production in the 5 years following independence in 1960 was 33,400 metric tons versus an 81,500 ton average between 1978 and 1982. Robusta production continued to grow through the mid-1980s with the three highest production years on record occurring from 1984/85 to 1986/87 (Figure 1). However, since the 1988/89 season, average annual robusta

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[2] Djomessi was also a founding member of COOPCOLV (Coopérative de Production, de Collecte et de Vente) created in 1948. This cooperative was created to serve the needs of unauthorized planters, who did not have access to the official cooperative CAPBCA (Coopérative Agricole des Planteurs Bamiléké du Café d'Arabie) created in 1933 for authorized planters. In 1976, COOPCOLV merged with CAPBCA to form CAPLAME (Coopérative Agricole des Planteurs de le Menoua).

[3] The premium in recent years has been around 40 percent, the highest since the early 1960s. This is attributed to changing tastes and a substitution of arabica coffees for robusta in instant coffee production which occurred at low world prices (World Bank, 1992).

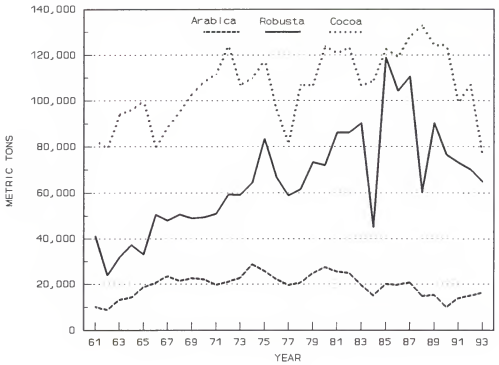

Figure 1. Annual Coffee and Cocoa Production in Cameroon, 1961-93.
Sources: USDA/FAS, World Coffee Situation, 1993; MINAGRI, Annuaire de Statistiques Agricoles, various issues.

production has fallen by 26 percent (USDA/FAS, 1993).[4] The increase in coffee production through the mid 1980s was the result of area expansion rather than greater factor productivity. Land productivity of coffee production, while variable due to weather effects, has been relatively stagnant with estimated yields averaging 367 kg/ha from 1960 to 1977 and 336 kg/ha from 1978 to 1992 (Figure 2).

The expansion in the robusta sector was, in large part, the result of the Bamiléké migration in the 1950s, 1960s and 1970s from the densely populated western plateau into the sparsely settled fertile lands of the Mbo in the Moungo Division of the Littoral Province and the Kekem

[4] From 1984/85 to 1988/89 production averaged 96,876 metric tons; in the 4 years following the decrease in official price in 88/89 (470 to 155 FCFA), the average has been 71,160.

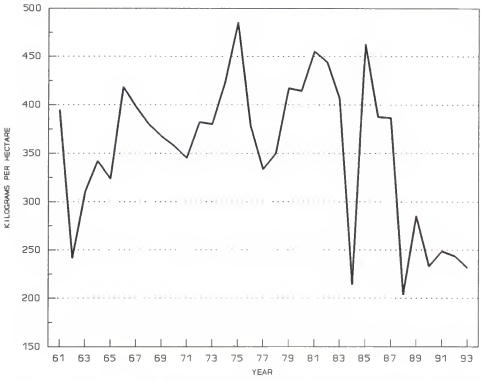

Figure 2. Coffee Yield per Hectare in Cameroon, 1961 to 1993.
Source: World Coffee Situation, 1993, USDA/FAS.

Subdivision of Haute Nkam in the West Province. Based on 1976 census results, Dongmo (1981) estimated that approximately 800,000 Bamiléké migrants were settled outside of their homeland. In the Moungo Division, which accounts for 35 to 45 percent of annual robusta production, Bamiléké migrants represented 71 percent (209,000 persons) of the total population in 1976 (versus 22,000 in 1947). Stimulating the growth of the industry was the fact that many of these migrants already possessed coffee production skills. The majority of the coffee holdings in the Moungo Division, considered the center of the Cameroon coffee industry, are held by Bamiléké migrants.

Uncertainty associated with the guerilla war, or *maquis*, waged against both the colonial and post independence regimes by the *Union des*

Populations du Cameroun (UPC) tempered the expansion of both arabica and robusta coffees in the 1950s and 1960s. Although the armed resistance began in the cocoa growing area around Edea, the center of conflict had moved to the West Province and to a lesser degree the Moungo division of the Littoral Province by the late 1950s. A state of emergency was in effect the entire decade of the 1960s in areas of the West Province. The unrest finally died with the capture of Ernest Ouandie, the last of the underground leaders in 1970.

Cameroon is located in west-central Africa, and was one of the few African nations to achieve steady economic growth following its independence. From 1960 to 1977, real GDP growth was 3.0 percent with the engine of this growth arguably the outward-oriented agricultural economy (Figure 3). A serious worsening of the terms of trade in the second half of the 1980s and the depreciation of the dollar were major factors in the prolonged recession that began in 1987 (Figure 3).[5] Real GDP from 1986 had declined at an annual rate of -4.5 percent through 1993.

Agricultural exports accounted for 73 percent of the value of total merchandise exports from 1962 to 1977. And coffee and cocoa, dominated by small holders, accounted for 77 percent of the value of total agricultural exports (Figure 4). Over this period the mean annual growth in the value of agricultural exports was 7.1 percent, while the mean growth rate in the value of coffee and cocoa was 9.1 percent.

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[5] Cameroon's oil and coffee exports are priced in dollars. Comparing the 1981-85 mean of an export price index with the mean for the 1986-91 period reveals a 30.3 percent decline; coupled with inflation in import prices the resulting decline in the terms of trade was 40.5 percent. (Data taken from World Tables 1994, World Bank.)

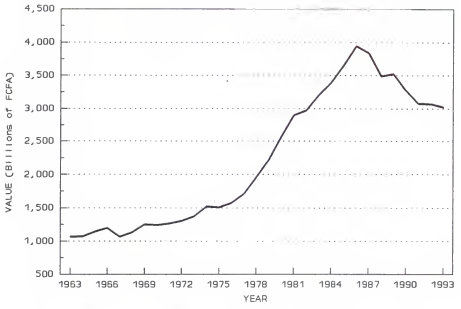

Figure 3. Real GDP in Cameroon, 1963-93 (1987 Constant FCFA).
Source: World Tables 1994, World Bank.

The Oil Boom and Its Effect on Export Agriculture

In the late 1970s, significant oil discoveries in the Bight of Biafra provided a boost to growth that averaged 10.4 percent from 1978 to 1986. With the discovery of oil, symptoms of the "Dutch disease" began to affect the agricultural sector (Benjamin, Devarajan and Weiner, 1989). While the more typical symptoms of the Dutch disease (severe currency appreciation and a siphoning of labor into the petroleum sector) were not manifested, a major spending effect caused prices and wages in the non-traded goods sector to rise (especially in the construction industry), which drew labor from the agricultural sector. Much of the spending effect was generated by a sharp increase in the size of the public sector stimulated by government oil royalties. The number of government employees increased from 77,000 in 1977 to approximately 183,000 employees in 1992.

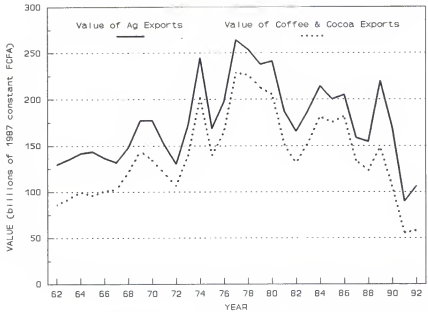

Figure 4. Value of Agricultural Trade in Cameroon in Constant 1987 Francs, 1962-92.
Source: FAO Trade Yearbooks, 1963 to 1988.

An implicit social contract between the government and its citizens existed in Cameroon following its independence based on a rigid structured relationship between educational achievement and the national labor code. Wage scales and advancement in both the public and formal private sector were based on employee educational qualifications. Those achieving a university degree were, up until the mid-1980s, guaranteed secure employment at a middle-class wage. One of the more prized sinecures was admission into the national agricultural university. All students of this university became employees of the state upon their competitive admission and were guaranteed lifetime employment upon graduation. The infusion of oil revenues into the economy through an expansion of these types of social contracts was associated with a stagnation in the agricultural

export sector and the coffee sector in particular. From 1978 to 1993, the annual growth in coffee exports was an insignificant 0.4 percent.[6]

The Nexus Between Export Growth and Economic Growth

The relationship between export growth and GDP growth was examined in an influential paper by Michaely (1977). Using rank correlation coefficients on a 41 country sample for 1950-73, he questioned whether the rate of growth of exports was associated with GDP growth. The correlation coefficient (.308) was significantly positive for the sample as a whole. It was larger (.523), however, for a subsample of 23 middle income countries. The same relationship was examined here for Cameroon. The independent variable, *EXP*, defined as the annual change in the ratio of exports of goods and services to gross domestic product, both measured in 1980 constant dollars, was regressed on the growth rate of real per capita GDP, *PERCAPGDP* from 1962 to 1980. The results (t-ratio in parentheses),

$$PERCAPGDP = 0.0342 + \underset{(2.00)}{0.2215}EXP \qquad R^2 = 0.20$$

confirm a similar positive relationship between export and GDP growth for the case of Cameroon. Given expanding coffee export earnings during this period, the regression evidence suggests coffee's important role in the overall growth of the economy in the 1960s and 1970s.

[6]The World Bank (1987) subjectively classified trade orientation in 41 developing countries into 4 categories: strongly outward-, moderately outward-, moderately inward-, and strongly inward-oriented for the 1963 to 1973 and 1973 to 1985 periods. Cameroon went from a moderately outward- to moderately inward-oriented classification.

Economic Agents in the Coffee Sector

Ntangsi (1987) classified Cameroonian interest groups affecting agricultural policy into five overlapping categories. Using his categories to classify the actors in the coffee sector we have (1) ethnic-regional groupings--the Bamiléké and Tikar coffee producers of the western highlands; (2) the peasantry, accounting for approximately 98 percent of total coffee production; (3) institutional groups such as the presidency, political parties, the National Produce Marketing Board (ONCPB), the Ministry of Agriculture (MINAGRI), the Ministry of Industrial and Commercial Development (MINDIC), and the marketing cooperatives; (4) urban-based elites, including marketing and processing agents and exporters, along with bureaucratic elites; and (5) external aid donors such as the World Bank, International Monetary Fund (IMF), the *Caisse Français de Développement* (CFD), and USAID.

Peasantry, Ethnicity, and Political Parties

Coffee in Cameroon is produced chiefly by Bamiléké and Tikar producers; these ethnicities account for 90-95 percent of the total arabica coffee and perhaps 50 to 60 percent of the robusta coffee. Political parties have formed varying degrees of alliances with these ethnicities in the relatively short modern political history of Cameroon with visible results on policy decision making.

In leading the struggle for independence with France in the late 1950s, the *Union des Populations du Cameroun* (UPC) drew the strong support of the Bamiléké of the West Province. However, because of a socialist ideology, the UPC was anathema to French economic interests, which declared it subversive and outlawed in 1955. A bloody guerilla war for

independence, fought mainly in the western highlands and in the Moungo Division of the Littoral Province, ensued and continued after independence against the French-backed Ahidjo regime. By 1963, government forces with the aid of French paratroopers and bombardiers had quelled most of the disturbance. The party of Ahidjo, the *Union camerounaise*, by 1964 had managed to coopt opposition parties into a single national party. In an attempt to win political favor among recalcitrant Bamiléké, in particular the elites running the cooperative enterprises, monopsony purchase rights for arabica coffee produced in the West Province and export selling rights in world markets were granted to UCCAO, the arabica cooperative marketing union in the West Province. The benefit of the right to export directly and to retain profits for the cooperative did not, however, benefit the producers of coffee in the West directly, because of statutes that prevented their being paid more than their counterparts in other provinces. Instead rents were to a degree reinvested in the rural community in the form of public good provisions.

Urban-based Elites: Marketing Middlemen and Exporters

The economic fortunes of urban-based marketing middlemen and exporters have been determined nearly from the inception of the industry by government regulation of their activities. In the robusta sector there are approximately 150 licensed buying agents of coffee, who collect and process the producer's coffee. In addition to these middlemen, there are approximately 60 licensed exporters of robusta coffee. Until recent reforms, exporters paid a fixed commission price to the licensed buying agents for collecting and hulling (mechanical removal of the dried cherry and parchment) the producer's coffee. They then sorted the green coffee

by size and quality, bagged it into the standard 60 kilogram export sacks and contracted sale on the world market, all at fixed commission prices determined by the ONCPB. In effect, the exporters acted as administrative agents of the ONCPB. In the arabica sector, these functions were carried out by primary cooperatives grouped under the cooperative apex organizations--*Union des Coopératives Agricoles de l'Ouest* (UCCAO) in the West and the Northwest Cooperative Association (NWCA) in the Northwest.

Prior to its dismembering in 1991, the ONCPB exported coffee produced in the anglophone areas of Cameroon (i.e. the Northwest and Southwest Provinces), while the arabica coffee of the West province was, as already mentioned, exported by UCCAO. In terms of their surplus gains, exporters have unequivocally the largest individual interests of any of the private actors in the coffee sector.

Bureaucratic Interest Groups and the Coffee and Cocoa Sector

Bureaucratic interest groups affect economic policies in the coffee and cocoa sectors in several ways: (1) indirectly through a macro-effect of the bureaucratic class on the demand for government revenues; (2) via their direct influence on the presidency through their sectoral policy analyses, and (3) through their implementation of government sectoral policies. As with any bureaucratic structure, opportunities for rent-seeking behavior can shape the behavior of the bureaucratic agent. The idea of bureaucratic rent-seeking and government acting as Leviathan to maximize its legitimacy by enlarging the public sector and the employment therein has been developed by Findlay and Wellicz (1984). In their model, tariffs are set to maximize revenues, which are then used to enlarge the state sector. This idea of the autonomous state has been extended to

explain the logic of marketing boards as a means of expanding state bureaucracy (Findlay, 1989).

At independence the new federal government inherited British and French export marketing organizations of differing natures.[7] In the former British protectorate of the Southern Cameroons, the National Marketing Board (NMB) undertook the physical marketing functions of collecting, processing, conditioning, and exporting robusta and arabica coffees and cocoa. In the former French protectorate, the *Caisses de Stabilisation* in contrast to the NMB, did not undertake physical exchange functions, which were the domain of licensed market agents paid a fixed commission determined annually by the *bareme* (the sets of administered official prices for the coffee and cocoa sectors). In essence the *bareme* established the price for every marketing function. In 1975, the two institutions were united into the National Produce Marketing Board, better known by its French acronym ONCPB, although functionally nothing changed in the way coffee and cocoa were exported from the two regions. The *bareme* was still issued annually by presidential decree after the recommendations to the presidency by the marketing board and the Ministry of Industry and Commerce.

Another important bureaucracy is found in the coffee cooperative movement. UCCAO was the most financially powerful cooperative because of its special exemption to export. Elsewhere, in the NWCA and among the robusta cooperatives, margins were either determined by the *bareme* or the

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[7] In October 1961, a UN-supervised plebiscite to decide whether to join Nigeria or the francophone Republic of Cameroon was held in the former British Protectorate of the Southern Cameroons. The population voted to join the Republic of Cameroon as the Western State of the Cameroon Federal Republic.

ONCPB and therefore these cooperatives were not as successful financially as UCCAO.

Over the two identifiable booms in the coffee and cocoa markets since 1975, the ONCPB generated positive surpluses, which were to be retained for years when world prices were low. However, after the collapse of oil prices in early 1986 and the growth in the public sector discussed above, the government with limited revenue options turned to the stabilization fund surpluses generated by high world prices for coffee and cocoa in the mid-1980s. In 1986/87, the financial woes of the ONCPB grew rapidly as cocoa prices dropped, followed in 1987/88 by coffee prices. The continued slide in commodity prices and the exhaustion of the ONCPB stabilization funds resulted in widespread payment arrears in 1988/89 to both marketing agents and producers in the cocoa and coffee sectors (over $300 million).

With the government budget in serious deficit and the ONCPB nearing bankruptcy, the last among Ntangsi's interest groups--the external donors--began to play a significant role in the economic deregulation of the coffee and cocoa sectors.

External Donors, the Presidency and the Bureaucracy

In 1988, faced with significant internal and external deficits, Cameroon negotiated a standby agreement and compensatory financing facility with the IMF. In 1989, a World Bank Structural Adjustment Loan (SAL) for $150 million and a five year reform program were agreed upon, with the SAL to be disbursed in three tranches. It was agreed that a financial audit of the ONCPB was required to guide its restructuring. Based on the results of the audit, the World Bank recommended the

dissolution and liquidation of the ONCPB whose work force had grown to over 2,800 employees. The presidency was opposed, and in September of 1990 the World Bank froze the second tranche of the SAL, while the IMF suspended Cameroon's standby arrangement, citing the slow implementation of the agreed-upon reform package. With approximately 100 billion *Francs Coopération Financière en Afrique Centrale* (FCFA), required to settle all its outstanding debts to producers and market agents from the 1988/89 campaign, the government of Cameroon turned to a coalition of European donors: the *Caisse Français de Développement* CFD and the European Community. Funding in the amount of 52.2 billion FCFA was provided in 1990 by the CFD and the EC through the Stabilisation of Export Earnings Scheme (Stabex) and the European Development Fund (EDF) (institutions established by the Lomé Convention). The funds were used to settle a large part of the arrears from the 1988/89 season and for prefinancing the 1989/90 campaign following a major restructuring of the ONCPB. Its work force was reduced from over 2,800 to 1,700 and its annual operating budget cut from 12.5 billion to 5 billion FCFA. In 1990/91 with continually falling coffee and cocoa markets and the external donors creating pressure for further reforms, the ONCPB was finally dissolved and replaced by the Office National du Café et Cacao (ONCC) with a staff of 157.

The exporters meanwhile organized themselves into the *Groupément des Exportateurs* (GEX), mainly in response to a compression of the *bareme* in both 1989/90 and 1990/91. Changes in the *bareme* greatly impacted the surpluses of both producers and marketing agents in the robusta sector from 1988 to 1992. The ability of the various economic agents to supply

lobbying pressure is examined in more detail in chapter 4 of the dissertation.

The charter of the newly created ONCC explicitly states that it will not be involved in any physical market activities. It is charged with supervising sales, controlling export quality and representing the country's interests abroad. In the robusta sector it has continued to administer a price stabilizing mechanism that retains many features of the old *bareme* system. Through the 1993/94 campaign, the government of Cameroon still set the official robusta producer price and the c.i.f. reference price of the exporter (in negotiation with the *GEX*), but all other marketing costs were free to adjust according to internal supply and demand for the marketing services of the licensed buying agents. As in the past if the world price is higher than the c.i.f price set by government (equal to the producer price plus the exporter's fixed margin), the difference is to be paid into a stabilization fund at the *Banque des Etats d'Afrique Centrale* (BEAC), the central bank (rather than the national treasury, as was previously the case).

In the arabica sector, owing significant arrears to the NWCA, the ONCPB relinquished its control of the export marketing of arabica coffee from the Northwest Province in 1990 and provided the NWCA with the right to sell its members' coffee directly on the world market. As an enticement to liberalization efforts, USAID and the EC funded the Programme of Reform in the Agricultural Marketing Sector--Arabica Coffee Sub-Sector (PRAMS), whose $18 million mission was to strengthen the NWCA in order that they might successfully compete in a fully liberalized market. As part of the structural adjustment reform package, the arabica

coffee market was liberalized in 1992/93, with prices freely determined in the market and all statutes regarding monopsonistic cooperative marketing rescinded.

The final major external agent of change in the coffee markets has been the French central bank. From 1948 to January 1994, the value of the FCFA has been maintained at a rate of 50 FCFA to 1 FF. As of January 14, 1994, the rate was pegged at 100 FCFA per FF. The resulting effect of a doubling of the FCFA price of tradable goods, combined with the recent upturn in world coffee prices and the liberalization of the coffee markets, caused producer prices for arabica coffee to rise significantly from under 200 FCFA in 1993 to over 500 FCFA as of April, 1994.[8]

Statement of the Problem

The Cameroonian government is in the process of liberalizing its coffee and fertilizer markets. The outcome of this liberalization will depend on the responsiveness of the Cameroonian small holder to price incentives. The long-run effect will be determined in large measure by the price responsiveness of replanting and new planting behavior by coffee producers. Information on this responsiveness and its systematic variation is a critical input to forecasting the likely effects of the recent policy changes.

A problem in Cameroon as in many economies is a lack of information on the response of the producer's investment decisions to price variables, i.e., the long-run supply response. To overcome the aggregate data lacuna a micro-level model of long-run supply response was developed for the use

[8]Based on information gathered in a short visit during April, 1994 to Dschang, West Province.

of panel data on investment variables at the farm level. Given the heterogeneity among coffee farms and numerous corner solutions in investment behavior at the micro-level, the supply model combined a fixed effects panel estimator with a Tobit censored regression model.

An understanding of the political economy underlying the wide array of government policies in the coffee sector is critical to prescribing sustainable policy reforms. What forces shaped 30 years of marketing board/stabilization fund intervention in the coffee market? What led government to relinquish its control in the industry? To gain insights on these questions, models of the policy making process were developed.

CHAPTER 2
EMPIRICAL AND THEORETICAL CONSIDERATIONS IN THE STUDY OF COFFEE SUPPLY RESPONSE

Primary Commodity Production in Economic Thought

Economic historians such as Douglas North and Harold Innis have emphasized the important role played by primary commodity production in the economic development of the U.S. and Canada. Cotton was crucial in the growth and expansion of the early U.S. economy, particularly in the 1820s, 1830s and 1840s. Surprisingly, the greatest regional economic benefits from the booming cotton trade of this period accrued to the northeastern states, which provided the bulk of the financial, transportation, insurance, and marketing services in the cotton trade with England and benefited from a widened market for its manufactures. North (p. 68, 1961) argues that

> it was cotton that initiated the concomitant expansion in income, in the size of the domestic markets, and creation of the social overhead investment (in the course of its role in the marketing of cotton) in the Northeast which were to facilitate the subsequent rapid growth of manufactures.

North (1959) has elsewhere argued that the successful production of agricultural commodities can be a prime inducement for economic growth, external economies, urbanization and eventually industrial development. His analysis focused on explaining differentials in growth rates between regions from a given increment in export income. Differentials are

explained by, *inter alia*,

> 1- the impact of differing natural endowments on comparative advantage and diversification. Does the resource base enable the production of a wide array of goods or is the comparative advantage for the initial commodity so great as to stifle diversification?
>
> 2- the structural characteristics of the export industry, e.g., plantation versus smallholder. Structural differences can lead to differences in the valuation of investing in human capital.[1]
>
> 3- changes in technology and transfer costs. Changes in technology can directly lead to diversification.[2] While transport cost reductions initially may tend to increase the comparative advantage in the premier crop, eventually, the external economies of improved communication facilitate the development of other industries. However, indigenous cottage industries may suffer from an infusion of cheap imports depending on the import elasticity of a region.

Successful examples of commodity-led U.S. regional development according to North (1961) are the Midwest from 1815 to 1860, the Pacific Northwest from 1880 to 1920, and California from 1848 to 1900. A similar line of reasoning is found in the staple theory of development originally put forth by Harold Innis (1927, 1940) in his analysis of the historical development of the Canadian economy and the roles played by the cod fishery and the fur trade. The net effect of an increase in exports on growth and development depends on the accelerator-multiplier effect of the increase in income derived from an expanding export sector. Borrowing from Hirschman's (1958) typology of linkages, this effect will vary depending on the degree and number of backward, forward and final demand linkages between the economy and the export industry (Watkins, 1963).

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[1]The hypothesis is that small-holder production will lead to a greater demand and incentive for education on the part of the rural population.

[2]In the case of the Cameroon coffee sector, farmers were introduced to new techniques incorporating the use and application of farm chemicals. These techniques are now being used in numerous other commercial agronomic enterprises, which have in certain areas supplanted coffee as the main commercial activity.

Myint (1965) argued that the scope of these linkages is much greater in peasant-based export production than in the plantation sector. In the former, the proceeds are divided between foreign exporters and domestic producers. In the latter the proceeds are divided between the foreign capitalists and unskilled labor.

Myint distinguishes two types of subsistence agriculture--an initially closed, nonmonetarized community, self-sufficient in meeting basic human requirements and a Malthusian situation of minimum subsistence where resources and technology are just sufficient to support the population (in effect the dichotomy is that of land- versus labor-surplus economies). The traditional agricultural system in a land-surplus economy prior to the introduction of the export crop fits Schultz's (1964) "poor but efficient" conception of traditional agriculture, where the "state of the art" and the state of preferences and motives for work versus leisure both remain constant. The recognition by the peasant that he or she is "poor" only comes after the introduction to new goods results in the development of new material wants. It was this newly instilled demand that was the driving force in the autonomous change in the state of the art (as represented by the introduction of export crops) that occurred in many of the peasant societies of West Africa and Southeast Asia in the late 19th and 20th centuries. The surplus resources in these societies were mobilized in proportion to the development of wants-stimulating communication and transportation networks. In contrast to a labor-surplus society, the marginal product of labor in these peasant societies was not zero; disguised unemployment in the sense used by some dual sector theorists did not exist.

The adoption of export crops into the traditional farming system was also facilitated by a relatively low financial capital requirement for the formation of the tree stock or rice paddy capital, which was often funded out of the subsistence surplus. While the plantation sector represents the extension of modern economic organization and technology, the production of the new export crops often required only slight modification of traditional techniques (e.g., cocoa in Ghana, oil palm in Nigeria and rice in the deltas of Southeast Asia). The models of Myint, North and Innis are all founded on the existence of a surplus resource available for exploitation. Thus agricultural growth in these models is contingent on the continued existence of the surplus resource. Once the slack in the resource is exhausted, continued agricultural growth becomes dependent on technological change increasing the productivity of the resources employed. Eventually, low levels of agricultural research, soil fertility, land and water infrastructure, and human capital become limiting factors in the continued growth of the agricultural sector.

A more pessimistic view of the benefits accruing to primary commodity production is found in the structural and dependency theories originating among Latin American scholars in the 1950s. A major focus in much of their discussion of primary commodity trade is the secular decline in the terms of trade faced by commodity producers. The unequal exchange perspective of the Latin American structuralist school led by Prebisch (1950) in the 1950s has had a major impact on Third World economic thought. The terms of trade deterioration is seen as resulting from the inherent structure of demand and supply in world markets for primary commodities. The structuralist school in contrast with dependency

theorists advocates the reform of international trading relations through the establishment of trade cartels and international organizations such as the UN Economic Commission for Latin America and the UN Conference on Trade and Development (UNCTAD), both headed at their inception by Prebisch, through which the call for a new international economic order (NIEO) was issued in the 1970s.

By 1975, following the actions of OPEC in controlling world petroleum supply, the perception of "commodity power" was at its height (Bhagwati, 1978). Among the provisions in the Charter of Economic Rights and Duties of States, produced by the UN General Assembly's Sixth Special Session on raw materials and development, were the rights to establish commodity producer associations of developing countries and to index commodity export prices to the import prices of industrialized countries. With the backing of the OPEC countries, the call for a NIEO attained its most noteworthy accomplishments at the Seventh Special Session of the UN when the U.S. agreed to a system of compensatory financing in the world commodity markets by the IMF and continuation of the Generalized System of Preferences for goods exported by the less developed states (Archer, 1983).

In contrast to the reformist approach of the structuralist school, dependency theorists call for the severance of economic relationships between the center and the periphery as the only viable solution to the underdevelopment of the periphery. International economic relations are seen as the root cause of underdevelopment (Baran, 1957; Dos Santos, 1970; Amin, 1990). Capitalism in the periphery, it is argued, has been achieved through the transfer of modern industrial enclaves, which developed

alliances with ruling elites leading to the development of authoritarian states. The failure of capitalism to generate growth in the periphery is seen as a failure to engage an indigenous class of entrepreneurs. De Janvry (1981) stresses the capacity of capitalism to expand output greatly in the periphery, but because of "social disarticulation" demand and production capacities do not coincide. The final demand for capitalist production consists of export demand and luxury good import demand driven by capitalist surpluses.

The influence of the Latin American structuralist school and dependency theorists on economic thought and policy in the 1950s, 1960s and 1970s in the nonaligned countries was great. Its recommendations were manifested in import substitution strategies to encourage industrialization that often concurrently reduced incentives to agriculture and especially traditional exports. Many mainstream economists in the 1950s supported a bias against agriculture based on grounds of comparative productivity (Viner, 1952). Albert Hirschman (1958) emphasized the relatively greater linkage effects of industrialization versus primary commodity production. The neoclassical dual economy growth models viewed traditional agriculture as providing an "unlimited supply of labor" (Lewis, 1954) that could be "siphoned off by means of the investment activities of the landlord class and/or government tax policy" (Ranis and Fei, 1961, p. 538).

Sir Arthur Lewis saw the terms of trade deterioration as structurally related to the productivity of subsistence agriculture. An

improvement in the productivity of the food sector was a precondition to improved commodity terms:

> The contribution of the temperate world to the tropical world whether in capital or knowledge has in the main been confined to the commercial crops for export, where the benefit mainly accrues to the temperate world in lower prices. The prices of tropical commercial crops will always permit only subsistence wages until a change in capital and knowledge are put at the disposal of tropical food production for home consumption. The benefit of increasing efficiency in export industries goes to the foreign consumer; whereas raising efficiency in subsistence food production would automatically make commercial produce dearer. (Lewis, p. 191, 1954)

He notes that productivity must rise in all countries' subsistence sectors or capitalists will simply transfer export production to those countries where it has not.

The advice to diversify exports and reduce the production of traditional exports was often given by the World Bank and IMF in the mid 1960s. In a special report of the IMF executive directors, recommendations were expressed for "reducing those commodities which were in serious oversupply by domestic taxation . . . or exchange measures involving the imposition of substantial taxes through the exchange system" (IMF, 1969). The World Bank similarly advised African nations to limit their traditional exports in the 1970s and adopted a policy not to finance expansion of coffee and tea production (Lele, Gockowski and Adu-Nyako, 1994).

While the voices calling for an expanded role for agriculture and exports grew throughout the 1960s and 1970s, import substituting protectionism was still the leading development paradigm among many Third World policy makers. Enthusiasm for this paradigm began to diminish with the onset of the balance of payment problems in the 1970s, which forced many to seek the support of the Bretton Woods institutions. In exchange

for fiscal support, the IMF and World Bank sought to change policy regimes through the leverage of loan conditionalities. The situation was accelerated with the 1982 recession in the industrialized countries and the debt crisis. At the center of many of these policy reforms were the opening of the external sector and the liberalization of trade. These developments were given an impetus by cross-country studies examining the link between economic growth and trade orientation in the 1970s.

Little, Scitovsky and Scott (1970) and Balassa (1971) estimated point measures of effective rates of protection (ERPs) in manufacturing for developing countries. These were shown in many cases to be nearly double the nominal rates of protection (e.g., Balassa estimated a nominal protection rate of 86 percent in the Pakistani manufacturing sector versus an effective rate of 188 percent). The conclusion of these studies was that import substituting industrialization had been excessively encouraged at the cost of reduced incentives for agriculture and exports. Krueger (1978) and Bhagwati (1978) in a study sponsored by the National Bureau for Economic Research (NBER) took a more dynamic approach and examined the nexus between periods of liberalization with growth. Krueger cites the following superior properties of export promotion versus import substitution on growth performance (p. 284, 1978):

(1) relaxation of the link between agriculture and industry;

(2) greater opportunities to exploit economies of scale;

(3) competitive effects on individual firms; and

(4) a lesser likelihood of foreign exchange shortage.

She econometrically tested the hypotheses that more liberal regimes result in higher rates of export growth and overall GDP growth. Regressing

exports categorized as traditional and nontraditional on the real exchange rate for exports and a series of dummy variables representing various categorizations of trade regimes, she found that for nontraditional exports the real exchange rate had a significant effect on export growth; however in the case of traditional exports there was no effect, which she attributed in part to the failure of governments to pass devaluations through to producers. The dummy variables associated with more liberal trade regimes were significantly positive for both types of exports, suggesting that export growth was positively affected by increased liberalization. Her analysis of the Ghanaian cocoa economy from 1950 to 1970 is interesting in light of the current issues. Ghana over this period was characterized by an overvalued exchange rate and a significant degree of quantity restrictions on imports which prevented satisfactory export performance. It was argued that the ensuing lackluster export performance resulted in the stagnation of the Ghanaian economy over this period.

Krueger, Schiff and Valdes (1989) extend the analysis of trade regimes to the agricultural sector in a cross-country examination of the effects of both direct and indirect intervention in agricultural prices over time. Regionally, indirect taxation of agriculture in the form of exchange rate misalignment, domestic industrial protection, and exchange rate appreciation resulting from industrial protection was highest in Africa at an average nominal rate of 29 percent. When combined with a 23 percent level of direct taxation, achieved through marketing boards, official price ceilings, and export taxes, the overall taxation of

agriculture in Africa was significantly greater than any of the other regions in the study (Asia, Latin America and Mediterranean).

Building on the analysis of Michaely discussed in chapter one, neoclassical production functions were posited by Feder (1983) for the trade and nontrade sectors of an economy with exports included as a productive factor in the nontrade sector. At least three effects of trade liberalization have been postulated as affecting neoclassical growth rates: (1) the generation of positive externalities on nonexport sectors through improved management and greater access to production techniques, (2) a productivity differential in the export sector *vis-a-vis* the other sectors and (3) a reduction in directly unproductive (DUP) activities, i.e., rent-seeking. Feder tested the first two hypotheses for 31 semi-industrialized countries by regressing growth rates on a measure of export growth and found a significant positive relationship, which he interpreted as evidence that marginal factor productivities are higher in the export sector. The rent-seeking hypothesis has been examined by Gallagher (1991) for a set of African countries again by specifying two production functions, one for the output of real goods and services and another for the production of rents. Rent-seeking activity, given a fixed level of resources in the economy, implies a diversion of factors from productive activities, thus reducing growth in real goods and services. Neglecting nontariff barriers in his measures of rent-seeking, Gallagher finds that estimates of the level of rent-seeking were not significant determinants of growth in a neoclassical growth equation, but in general his results suffered from data problems as changes in the labor- and capital-output

ratios were likewise insignificant. One interesting result was the positive influence of a measure of political pluralism on growth.

Michaely's conclusion that "growth is affected by export performance only once countries achieve some minimum level of development" was pursued by Helleiner (1986) with an econometric formulation similar to that of Feder's but with the addition of a measure of import volume instability. His argument was that discontinuities in the flows of intermediate inputs and capital goods were damaging to growth. He estimated the growth equation for a sample of 24 African and 23 poor nations (1980 per capita incomes below $410) from 1960 to 1980. The effect of export growth and import volume instability were not significant in any of the regressions for the poor countries, nor was export expansion significant for the African countries. However, the effect of import volume instability was significant and negative for the set of African nations, leading to the conclusion that the increased availability of international finance in the 1960s and 1970s would have had a significant positive impact on the growth rates of African economies.

Edwards (1993), in a review of the empirical literature on the relationship between trade orientation and growth, criticizes the empirical and conceptual shortcomings of the cross-country regression studies. Conceptually, the models employed have failed to address in convincing fashion the exact mechanism through which export growth affects GDP and have ignored important determinants of growth such as educational attainment. Recent developments in endogenous growth theory somewhat overcome this critique, emphasizing the role of increased technology transfer (Grossman and Helpman, 1991), and the reduction of intermediate

goods constraints (Romer, 1986) in increasing equilibrium growth rates. However empirically, endogenous growth models, as the neoclassical cross country regression studies, have been beset by issues of endogeneity and difficulty in measuring the degree of openness.

The Lagos Plan of Action (LPA) for the Economic Development of Africa 1980-2000, adopted by the Heads of State of the OAU in April of 1980, outlined a strategy giving priority to food and agriculture and recognized the need "to provide small farmers and members of agricultural cooperatives with the necessary incentives to increase production" (OAU, 1982). The stagnation in food production was attributed in part to the priority given export crops. Concurrently, in the fall of 1979 the African Governors of the World Bank asked that the Bank prepare a special paper on the development problems of these countries that built on some of the strategies outlined in the LPA. The result was "Accelerated Development in Sub-Saharan Africa," also known informally as the "Berg Report" after its chief author (World Bank, 1982). The primary focus of the Berg report was on agriculture and the sources of stagnant or declining productivity. Rather than emphasizing the external and internal structural constraints of African agriculture as did the LPA, the report focused most of its attention on the impact of the policy environment and administrative constraints. Drawing from the exports-growth studies of the 1970s, the major policy distortions addressed were the existence of overvalued exchange rates, import substitution policies, and the bias against agriculture and exports. Specifically, in regards to export crops, the report documented the absolute decline of export volume in the 1970s, which was attributed in the main to the bias of overvalued exchange

rates, panterritorial pricing of export crops with nominal protection coefficients indicating taxation levels of 40 to 45 percent on average, and inefficient marketing boards not subject to competitive forces. The program advocated for reviving growth in African agriculture was multi-faceted, but recommended at its core a strategy of selective small holder development targeted to those areas where the physical and human resource base offered a rapid and high payoff. The experimentation of the 1960s and 1970s with large-scale government operated estate agriculture were negatively viewed.

Many of the recommendations advocated in the Berg report are currently being implemented in the plethora of structural adjustment programs undertaken in Africa since the early 1980s. As such, the response of African agriculture to price and exchange rate incentives has become an area of recent empirical research.

The aggregate response of agriculture to a change in the domestic terms of trade will likely be small in the short-run because of the fixity of resources between sectors, and institutional and infrastructural bottlenecks; in the long-run, the response will be larger as the result of private decisions to migrate and invest (Binswanger, 1989). The response to an exchange rate devaluation will also depend on the proportion in the agricultural sector of tradables versus nontradables. If the sector is dominated by nontradables (in the African context, mainly root crops and plantains) and uses a significant proportion of imported inputs, then the net effect could be a decline in the internal terms of trade and a reduction in output. Finally, the response to a real depreciation should

favor the production of export crops over nontraded food crops, so that the effect of a depreciation on export agricultural response will be greater than the aggregate agricultural response.[3]

In a supply response model of the industrial, services, and agricultural sectors with three factors of production (labor, private capital and public capital), the aggregate short-run supply elasticity of agriculture was positive, but not significantly different from zero, in a pooled cross-sectional analysis of 26 adjusting sub-Saharan countries (Faini, 1992). In a subsample excluding the low income economies, the price coefficient was larger than in the full sample, suggesting differences in supply response that depend on the level of development. Importantly, Faini finds that public investment in agriculture had a positive influence on aggregate agricultural supply in the full sample, but a negative effect when the low income countries were excluded. The inference drawn was that the effect of public investment is relatively more important to low income countries, where accumulated deterioration of physical capital is acute and a serious constraint to the functioning of factor and product markets.

Estimates of the short-run aggregate supply response ranged from 0.05 to 0.76 in two time-series analyses among 16 African nations, however, fewer than 1/4 of the total estimates in the two studies were significantly different from zero (Bond 1983; Berthélemy and Morrison,

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[3] Concern for the impact of this shift in product mix on food security, especially in the face of poorly functioning rural food markets, has been expressed in the Lagos Plan of Action and elsewhere (Economic Commission on Africa, 1990; Lele, 1975).

1989). Estimates of the long-run supply response are fewer because of the lack of reliable, sufficiently long, time series data, especially for African nations. In the long-run, the aggregate supply response to price was estimated to be 1.78 after a 20 year adjustment period to a permanent price change for Argentina (Cavallo, 1988).

The short-run elasticity of African agricultural exports with respect to current producer price was estimated to be 0.24 in a pooled cross-sectional analysis (Jaeger, 1992). In the same study, the hypothesis that increases in export crop production result in decreases in food crop production was tested by regressing food production on an index of export crop prices. The coefficient on the export crop price was positive, implying that food and export crop production are complementary. This result, however, was subject to an omitted variable bias as the price of food was not included. The ratio of exports to output had an elasticity of between .8 and 1 with respect to changes in the real exchange rate for SSA countries (Belassa, 1989). Single crop supply response estimates using a Nerlove supply model have, in general, been greater than the aggregate estimates, although in developing countries most elasticity estimates are significantly less than one (Askari and Cummings, 1977).

Review of Perennial Crop Supply Response Literature

The supply analysis of perennial crops is complicated by the intrinsic dynamic structure introduced by the biological lags between the time of planting and the harvesting of output. Decisions made today will affect well into the future the constraints of the production system. Early efforts at modelling perennial tropical crop supply response

principally made use of Nerlovian supply models. In this model, the dependent variable is specified as either area planted or output. Typically, desired output or acreage planted is assumed to be a function of expected price. Adaptive price expectations are assumed, where the expected price in period t is a weighted average of the actual price in period t-1 and the expected price in period t-1. Likewise, the desired output in period t is a weighted average of the desired output and the actual output from the previous period. The producer is assumed to be moving towards some "long-run" equilibrium position different from their current position.

Bateman (1965) was among the first to adapt the Nerlove model to the long lags between planting and harvesting which characterize perennial crops. He estimated regional supply functions for Ghanaian cocoa by substituting a model of new plantings with adaptive expectations into an output equation which related vintage to yield under the assumption that farmers seek to maximize discounted present value of expected profits with respect to planted acreage. Yield was assumed constant after 12 years, and trees infinitely-lived, resulting in an output equation with an infinite time horizon. To estimate, first differences were taken, and output was regressed on own-price and the price of coffee lagged 8 and 12 years, rainfall, and humidity (the prime determinant of blackpod disease, a major problem for cocoa producers). Bateman's estimates of the expectations coefficient were close to one, leading to the conclusion that cocoa farmers react mostly to current price (they have naive or myopic expectations) in their planted acreage response behavior. Estimates of the long-run supply elasticities ranged from 0.42 to 0.87 for 1949-62.

In a similar modelling effort, Behrman (1968) modified Bateman's approach by using a partial adjustment model with adaptive price expectations for desired cocoa acreage in a study of eight West African cocoa producing nations. As acreage data were not available, its equation was substituted into an output equation and estimated in first differences. His aggregate results generally showed significant "long-run" response, but were not as robust as those of Bateman, which was attributed to the omission of weather variables and the level of aggregation.

Uganda coffee producers and Nigerian and Ghanaian cocoa producers were the focus of a supply response study by Ady (1968). Again, data limitations forced reduced form estimation of output with substituted price expectation proxies for new planting à la Bateman and Behrman. The estimation results for cocoa were improved by accounting for a change in expectations formulation following the imposition in 1939 in both Nigeria and Ghana of statutory marketing boards. This was handled through the inclusion of the lagged expected world price of cocoa. In harmony with Bateman's results, Ady's modelling efforts were most successful using naive expectations of price rather than adaptive expectations as used by Behrman. However, her measure of the dependant variable--the difference in annual production--and its regression on production lagged one period raises a question of specification error.

One of the earliest attempts at modeling perennial crop response was conducted by French and Bressler (1962) for California lemon producers. Acreage and age composition data permitted estimation of new planting as

a function of long-run profit expectations and the existing age composition of the tree stock. French and Mathews (1971) developed a model, tested on California asparagus producers, consisting of equations for new plantings, replantings, and a yield equation. These equations were functions of variables measuring expected profitability. Again because of data limitations, the plantings and replantings equations were combined in a reduced form for acreage changes, which was regressed on current and lagged price, current and lagged harvested acreage, and a shift variable for changes in the policy regime. The model was underidentified and, as in the other studies, structural parameters were not recoverable.

These early attempts at perennial crop response were criticized for their use of single equation reduced forms and ad hoc lag structures superimposed on static models, which failed to distinguish between long-run investment decisions and the short-run response to price changes (Griliches, 1967; Nerlove, 1972 and 1979; Wickens and Greenfield, 1973). Furthermore the assumption that only the extensive margin, i.e., planted acreage, adjusts neglected various other margins of adjustment at the producer's disposal (Trivedi, 1986).

Wickens and Greenfield (1973) derived a stock demand function for new plantings from a neoclassical adjustment cost model. They also specify a short-run harvesting equation to capture deviations in actual yield from planned potential yield, as determined by a vintage production function. These deviations are explained by recent price behavior. Their theoretical approach innovatively incorporated the vintage production function as a constraint in the dynamic optimization problem of the firm,

thus introducing biological dynamics in a logical rather than ad hoc fashion. However, assumptions of fixed proportions technology between the tree stock and variable inputs, quadratic planting costs, no carryover effects from variable inputs, no technical change, and complete harvesting of all potential production were necessary in order to derive an analytical solution for the level of new planting expressed as a function of certainty equivalents for unknown future prices. Again because of data limitations, they estimated a reduced form distributed lag output equation in testing the model on Brazilian coffee. While the structural parameters were not recoverable because of data limitations, the shape of coefficients on the distributed lag of price was proportional to the age-yield profile of the vintage production function.

French, *et al.*, (1985) had access to detailed data on new plantings and removals by California cling peach producers. Using these data they estimated separate OLS equations for each. The ratio of expected future average annual production from existing acreage to current expected production was a significant factor in reducing new plantings. Their interpretation was that if the age structure of a producer's orchard is such that future output will be increasing, then the current incentive to plant is lower. They also assumed a naive model of expectations, i.e., a lagged 4 year moving average of deflated net revenues to measure the effect of price expectations on new planting response. This variable was significantly positive and resulted in a new planting elasticity estimate of 1.68 at the mean.

The Wickens and Greenfield (WG) reduced form approach was used by Dowling (1979) and Dowling and Jessadachatr (1979) to estimate the supply

response behavior of Thai sugar cane and rubber producers. The shapes of the coefficients on Almon distributed lags of prices were found to be proportional to the age-yield profiles of these crops. The appropriateness of the WG formulation, which focuses only on new plantings, will depend on the maturity of the industry. When a perennial crop industry has existed for a long period of time, costs of new planting may become prohibitively high as lands for new investment become scarce. In such circumstances, the investment decision of the producer becomes the optimal replacement of a capital asset. An example of such an industry is the Sri Lanka rubber industry.

Levels of new planting in Sri Lanka were relatively insignificant in comparison to replacement of old stock according to Hartley, Nerlove and Peters (1987). They modified the WG formulation by deriving a replanting stock demand equation from the firm's dynamic optimization problem subject to a vintage production function. In deciding whether or not to uproot and replant, a farmer must compare the current net returns and the discounted future stream of revenues from the old stock to the discounted future revenues from the replacement; these revenues will be functions of the genetic stock, and uncertain future prices. The replanting function was linearized and estimated as a function of "expected normal price," the difference between current price and "expected normal price," replanting subsidies, the age composition of the current tree stock, and the wage of labor.[4] They had access to data on both new plantings and replantings and were able to derive an empirical estimate of the vintage production function. The results of the model were robust for the replanting and

[4]That is $P_t - P^*_t$, where $P^*_t = (1-\beta)P^*_{t-1} + \beta P_{t-1}$.

output equation, but not so for the new planting equation, as new plantings were an insignificant element in the long-run supply response of Sri Lankan rubber producers. Based on these results and unsatisfactory attempts to estimate the WG reduced form for the Sri Lankan rubber industry, they cautioned against its indiscriminate use for modelling perennial crops especially in mature industries.

Nerlove (1979) discussed various aspects of translating the solutions to the firm's dynamic programming problem into an econometrically estimatable rational model. One of the chief requirements is the assumption that certainty equivalents exist for unknown future prices, yields and costs. His expressed reservations for this assumption were based on: (1) the nonlinear constraint that harvested output is bounded by potential output, (2) the discontinuous nature and uncertain timing of technological change, and (3) the stochastic effects of weather and disease on yields. He pointed out, that unless such certainty equivalents exist, the solution to the dynamic optimization model for the new planting and replanting equations "no longer represents a structure into which we can introduce (conditional) expectations based on time series of past prices, costs and yields." In a developing country this problem is likely to be compounded by the volatile nature of demographics, technical change, prices, and politics. The indeterminacy of the problem has also been noted by Trivedi (1986), who showed that unique paths of new plantings and replantings may not exist for a given configuration of prices. In this case the concept of long-run supply elasticity is not well defined.

The issue of uncertain future prices and yields (due to the vagaries of weather) under the assumption of no technical change was investigated in a WG formulation of new plantings for the relatively young California almond industry (Dorfman and Heien, 1989).[5] Optimal new plantings were a function of the expected present value of almonds and the discounted covariance of net returns and yields. A model with a proxy variable for this covariance fit the data better than the WG model or an accelerator-investment equation. The equation had larger, more significant coefficients on expected present value of new plantings than the WG model and showed a positive and significant effect to the variance measure. The positive effect may be rationalized as a desire for excess capacity in the face of uncertain prices and yields. They concluded that uncertainty was important in explaining investment in the California almond industry.

Trivedi (1986) developed a model where levels of replanting, new planting, uprooting of vintages, technology, choice of vintages and variable inputs are chosen by a competitive firm maximizing net discounted revenues. He offered several useful insights in the modelling of supply response noting that *inter alia*: (1) the production from the current capital stock depends not only on current inputs, but is also conditional on past application of variable inputs; (2) short-run responsiveness to price and cost will occur at the intensive (intra-marginal capital) margin induced by changes in the value of the marginal product of labor and at the extensive margin as the set of profitable vintages is affected; (3) the response to price in the short-run is caused by a divergence in actual

[5] Nickell (1976) argued that uncertainty and risk aversion explain sluggish investment behavior better than convex adjustment costs.

price and cost from expected levels and, given both extensive and intensive adjustments at the margin, results in a divergence of planned (profit-maximizing) output from actual output; (4) there exists the possibility of labor-labor substitution as labor is moved between capital of different vintages to equalize marginal revenue product across all vintages; and (5) if labor and other variable inputs are substitutable for capital, the age-yield profile is no longer a technical relationship, but rather is economic and will depend on the wage-rental ratio. It was also pointed out that the concept of long-run response is complicated by the fact that a stationary state for the vector of capital stock vintages may not exist. He argued that a more meaningful calculation of supply response would measure induced changes in feasible output over a specific time period.

Akiyama and Trivedi (AT) estimated error correction models (ECMs) for new plantings, replantings and uprootings of tea in Kenya, Sri Lanka and India (1987). The ECM has been shown by Nickell (1985) to be derivable from a dynamic cost of adjustment model similar in spirit to the model of Trivedi. The desired level of new planting in the AT model was a positive function of the shortfall in profitable productive capacity at time t and that desired in time t + G where G is the biological gestation lag. These capacities were calculated conditionally on expectations of future profitability. Naive models of expected price and costs were used to represent future profitability.

Trivedi (1992) investigated the replanting and new planting behavior at the aggregate level for the Brazilian cocoa industry using a cost of adjustment model of investment. Explaining that the existence of closed

form analytical solutions to the dynamic programming problem of the firm may not exist given arbitrary functional forms for the production function and arbitrary time paths of expected future prices, he chose to use "simple restrictive functional forms . . . without going through the difficult intermediate steps of deriving them from explicit parametric forms." Utilizing equi-marginal principles, the expected marginal revenue from the planting (replanting) of a cocoa tree (which is a function of expected gross revenue per hectare, revenues lost from uprooted stock in the case of replanting, and the discount rate) was equated to the marginal cost of investing (which is a function of the interest rate and the unit price of land). The results for the replanting equation indicated a significant negative short-run response to the price of cocoa due to an increase in the revenue lost from uprooted stock. However, the long-run effect was dominated by the increase in expected gross revenues, so that overall the estimated elasticity of replantings to price was 1.7. The new planting equation was limited by the lack of an age-yield relationship for the calculation of expected profits. Instead, real price lagged one and two periods and the real interest rate as a proxy of the discount rate were used to model the expected profitability of new plantings. The installation cost was assumed to be positively related to the quantity of "newly installed capacity". The price elasticity of new plantings estimated at the means was 1.60.

As seen above, many of the studies on perennial crop study have had to resort to reduced form estimations because of data shortcomings on the investment decisions of producers. Kalaitzandonakes and Shonkwiler (1992) overcame this by using an innovative combination of latent variable

techniques and structural time series analysis to recover structural parameters for new plantings and replantings, although only aggregate total plantings data were available for Florida grapefruit producers. Their state-space model performed better than a Nerlove partial adjustment model in terms of the R^2 criterion and in its predictive ability.

Most empirical studies of perennial crop supply response have estimated aggregate supply functions under the assumption of a competitive representative firm. Kirman (1992) points out that tests of a representative agent model are tests of a joint hypothesis--that of the particular behavioral relationship under study and the hypothesis that the choices of the aggregate can be represented by the choices of a single maximizing agent. When these models are tested and rejected, the rejection may be due to the inappropriateness of the representative agent assumption. For example, empirical tests of representative agent models on aggregate demand data have consistently rejected the homogeneity and symmetry conditions from utility theory--but Kirman's critique raises a question as to which hypothesis we are rejecting. Stoker (1993) in discussing the consistent empirical findings of individual differences in economic behavior points out that

> no realistic conditions are known, which provide a conceptual foundation for ignoring compositional heterogeneity in aggregate data, let alone a foundation for the practice of forcing aggregate data patterns to fit the restrictions of an individual optimization problem.

An important source of heterogeneity among the coffee farmers of Cameroon is the degree to which the farm household relies on subsistence food production. When the firm also consumes its production, the assumption of a profit maximizing firm should be replaced by that of a

utility maximizing household firm. Rather than simply maximizing profits, the household allocates its time among commercial and subsistence production and leisure. Assuming complete markets for all goods, and exogenous prices, the household firm has been modeled as first maximizing profits subject to a production function constraint and then maximizing utility subject to income and time constraints (Singh, Squire and Strauss, 1986, Strauss, 1984; Nakajima, 1969; Lau, Lin, and Yotopoulos, 1978; Barnum and Squire, 1979).

In addition to a varying degree of subsistence orientation, the heterogenous nature of coffee production is also exhibited along numerous other dimensions. There is wide variation in the prices coffee farmers receive at a given point in time due to transaction costs and other factors. On the production side, biological lags and the inherent age-yield profile of the tree stock result in varying land productivities over time. The productive flow from the tree stock will also vary across farms with silvacultural practices, rates of fertilization, soil fertility, the topology of the farm and other agro-ecological factors. The age of the decision-maker can have an important influence on the planning horizon and the decision to invest. Variations in the level of rural infrastructure will affect supply response, as will the size, composition and age of household members.

Rather than ignoring the heterogeneity of coffee production as in aggregate measures of supply, a behavioral model of the coffee farm at the level of individual agents was developed. The model included dynamic biological effects, price expectations, heterogeneity in prices and the household composition. The supply model consisted of new plantings,

replantings, and the short-run supply equations given a fixed level of capital.

CHAPTER 3
ESTIMATION OF NEW PLANTINGS, REPLANTINGS, SHORT-RUN SUPPLY, AND FERTILIZER DEMAND

Micro-econometric models of investment behavior, short-run supply and fertilizer demand in both the robusta and arabica sectors were estimated using survey data obtained from the Department of Agricultural Economics at the University of Dschang.[1] The measurement of producer supply responsiveness to changes in revenue expectations and explanation of its variation were the primary aims of the analysis. The importance of this objective has been heightened by the recent pricing reforms, the FCFA devaluation, and stochastic shocks to coffee production in Latin America. Before proceeding to the model, a description of the survey data and the typical coffee household are presented.

Description of the Coffee Household Characteristics

An archetypal arabica coffee producer based on survey results was male, 54 years of age, with a low level of literacy, and typically polygamous in marriage choice (Table 3.1). The average farm size was between 4 and 5 hectares with coffee included in an intercrop with 3 or 4 other crops. A producer typically was the head of a household, which consisted of 1 to 2 other adult males laboring only part time on the farm, 2 to 3 full time female adult farm workers and 1 part time female adult

[1] The survey methodology used by the Department of Agricultural Economics is described in Appendix A.

farm worker. In addition, 4 dependents (under the age of 16) lived in the household. It was more likely that the producer was not employed off-farm.

An archetypal robusta coffee producer in the survey was male, 51 years of age, with a relatively higher level of literacy than his arabica counterpart (Table 3.1). The average farm size was between 5 and 6 hectares, again with coffee typically included in an intercropped system with 3 other crops. The average robusta household in the sample consisted of the producer, one other full time adult male farm worker, 1 to 2 part time male adult workers, 1 to 2 full time female adult workers, 1 part time female worker and 3 dependents under the age of 16. As with the arabica producer a typical grower had no off-farm employment.

A representative coffee enterprise in Cameroon was one of several productive enterprises in a household better described as a cooperative union of sub-households, with the coffee producer as the head of the apex household. Each sub-household consisted of a wife, who was typically a food producer and her children. The producer had a certain amount of control over the farm's resource, but not complete control. His revenues were largely derived from coffee, but other revenues from other cash crop enterprises, cash remittances from relations, and off-farm employment may have been important as well. Each of the female headed sub-households sought to maximize its utility subject to time and income, which was largely deriving from marketed food surpluses. Competition and cooperation in production occurred both among sub-households and among the apex household and the sub-households: there was strong competition over the land allocation--land often planted to coffee--for intercropped food

production; and cooperation in soil preparation, planting and weeding. Production of coffee and food were interrelated by extensive intercropping; the degree of intensity affected the output of coffee as well as food crops. Some labor from the sub-household was donated to the apex household, some was hired by the apex household or by rural labor markets especially at harvest in November, December and January when cash needs for preparing ancestor feasts and gift giving are high. Exchanges of fertilizer among the apex household and the sub-households were common.

Food consumption in each of the sub-households was mainly out of own production although a significant degree of sharing was also present. School fees for children were often considered to be the responsibility of the apex household, however, instances of sub-households paying part or all of the fees were not rare. Similar descriptions of the preceding conceptualization of the rural coffee household in Cameroon are to be found in Guyer (1980, 1984) with reference to chiefly cocoa growing households of the Beti-Bulu ethnicity of southern Cameroon, and in Goheen (1991) with reference to the Nso chiefdom of the North West Province.

High rural population densities characterize the arabica growing areas of the West Province and are a major reason for the smaller arabica farm size and a higher number of intercroppings with coffee in the West as compared to the Northwest Province.[2] Population pressure was also reflected in a somewhat lower proportion of West Province farmers indicating fallow fields on their farm as compared to other provinces.

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[2]Batcham subdivision of the West Province had a rural population density of 391 inhabitants per square kilometer in 1987. Among the 454 coffee fields in the province on which data were gathered, only 13 were reported as being pure stands of coffee; maize which competes strongly for nitrogen was associated with coffee in 62 percent of these fields.

Table 3.1. Selected Descriptive Statistics for Coffee Households in Selected Provinces of Cameroon, 1992.

	Arabica				Robusta					
	West		Northwest		Littoral		West		Southwest	
Variable	Mean S.D.	Max Min	Mean S.D.	Max Min	Mean S.D.	Max Min	Mean S.D.	Max Min	Mean S.D.	Max Min
Farm Size (hectares)	3.45 2.56	20 0.5	6.89 5.03	25 1	5.17 4.75	28 0.5	4.93 3.45	20 0.5	9.37 6.00	28 2.5
Age of producer (years)	54.4 12.7	82 15	54.0 10.8	79 30	53.4 13.2	81 25	48 12	78 23	53 11	73 27
Male ownership (%)	98%	---	93%	---	93%		97%		97%	
Schooling (years)	3.07 3.34	12 0	2.83 3.38	12 0	5.91 4.73	28 0	5.04 4.27	18 0	5.59 3.85	15 0
Intercrops (number)	3.81 1.71	9 0	3.65 1.76	8 0	3.50 2.25	8 0	2.51 1.93	7 0	3.24 2.12	8 0
Fallow fields (%)	47%	---	42%	---	93%	---	53%		90%	
Off-farm job (%)	22%	---	42%	---	14%	---	34%		7%	
Full-time men (number)	1.33 1.00	12 0	1.49 1.98	8 0	1.55 1.32	10 0	1.16 1.29	8 0	2.56 3.17	15 0
Part-time men (number)	1.51 2.20	12 0	1.49 1.98	8 0	1.24 1.67	8 0	0.94 1.43	5 0	2.11 2.28	10 0
Full-time women (number)	2.66 2.27	13 0	2.18 1.89	11 0	1.85 1.28	8 0	1.66 1.28	5 0	2.74 3.22	15 0
Part-time women (number)	1.07 2.09	12 0	1.11 1.47	8 0	0.61 1.16	8 0	0.68 1.48	7 0	1.74 2.21	8 0
Children-students (number)	3.58 4.49	27 0	3.72 3.53	18 0	1.60 2.44	10 0	3.71 5.40	28 0	3.26 4.11	18 0

Source: Survey of 500 coffee producers, 1992.

Overall, rural densities according to the 1987 census were the highest in the West Province with 65 inhabitants km^2, followed by the Northwest at 56, the Littoral at 53, and the Southwest at 23 inhabitants km^2 (Losch, *et al.*, 1990).

A Model of New Plantings

New planting, replanting, and regeneration of a coffee tree are, in essence, the three avenues open to producers wishing to change the vintage structure of their tree stocks. Regeneration is the process of cutting back the tree every 10 to 15 years in the case of single-stem pruning methods and every 9 years for multiple stem trees, and is one of the recommended practices in the coffee extension manual of the Institute of Agronomic Research (IRA, not dated). Regeneration as recommended by IRA was practiced by a very low number of farmers surveyed and was ignored in the analysis because of its low incidence. Replantings were commonly reported and were analyzed in the following section. The focus of this section is on estimating the response of new planting behavior to price and non-price factors.

The economic variable of prime importance in both the producer's new planting and replanting decision is the expected, subjectively discounted, future net returns from coffee production. These returns will be a function of expected future prices and costs, the adjustment costs of undertaking new planting, and the production technology. Expectations as to future net returns will vary due to *inter alia*: (1) varying transaction costs involved in the production and marketing of their coffee and food crops; (2) environmental differences in soil types and microclimates; (3) differences in family labor supply, shadow wages, and hired labor markets

(labor costs are by far the chief cost component in the production of coffee); and (4) differences in subjective discount rates among farmers.

Transaction costs are a function of the level of infrastructural and institutional development and have been shown to be of significant magnitude in the arabica coffee industry of Cameroon (Langham and Ayissi, 1991). Environmental factors stressed in the agronomic literature (Mitchell, 1988; Snoeck, 1988) include slope, soil condition, rainfall and sun exposure; as these variables vary from farm to farm the expected future returns would likely also vary. Social and demographic variables stressed in the innovation-adoption-diffusion literature (Griliches, 1957; Rogers, 1983) include human capital measures, family demographics, and communication processes. Incomplete, poorly developed labor markets, less than perfect substitutability among hired and family labor, and the dynamics of household demographics will influence the expected cost of labor. Labor costs are also affected by local variation in labor market conditions.[3] The difference in subjective discount rates is an unobservable effect that will also vary across farms.

In addition to the impact of expected future net revenues, adjustment costs of bringing new land into production will affect new plantings. In both the robusta and the arabica sectors, the land resource was generally passed by inheritance between generations, and only a very

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[3]A major influence on labor market supply conditions is the real exchange rate with neighboring Nigeria and its influence on migrant or semi-permanent labor movements. The migrant labor force for the arabica sector in Cameroon is mainly male laborers from the Northwest Province who often seek employment in Nigeria, especially when there is an overvalued niara. Until the recent devaluation of the FCFA, the flow was reversed with a significant number of Nigerian workers employed in the cocoa plantations of the Southwest. Data on the price of this labor do not exist. Piece rate data were obtained for the 1992 and 1988 seasons based on farmer recall of what they were paying.

limited market for land existed. The usual measure to be included in a new planting specification would be the price of land. With no possibility of measuring land values, this variable had to be omitted. Instead a proxy measure of the opportunity cost of land in robusta coffee production was the official producer price of cocoa. In the arabica sector, truck farms specializing in vegetable production for urban markets have increased in number and importance in many regions and have been substituted for arabica coffee production. Sufficiently long time series data on the net returns of these enterprises were not obtained.

The standard neoclassical analytical framework for the empirical analysis of new planting investment is based on net present value maximization of a model with vintage technology and convex adjustment costs (Wickens and Greenfield, 1973; Trivedi, 1986; Akiyama and Trivedi, 1987; Hartley, et al., 1987; Dorfman and Heien, 1989; Trivedi, 1992). The first-order condition for revenue maximization in this model is that new planting proceeds until the marginal expected net revenue from an additional coffee tree equals the marginal cost of investment. As Trivedi (1985) has pointed out, closed form analytical solutions may not exist, given an arbitrary functional form for the production technology and arbitrary time paths of expected future prices. In most of the studies, which have attempted to estimate a new planting equation directly, linear models have been used on aggregate data (Dorfman and Heien, 1989; Hartley, *et al.*, 1987; Trivedi, 1992).

The new planting functions for arabica and robusta coffee producers, respectively, were specified as:

$$NPARAB_{it} = f(CONS_i, EGRA_t, WAGE_t) \quad (3.1)$$

$$NPROB_{it} = f(CONS_i, EGRR_t, PCOCOA_{t-1}, WAGE_t) \quad (3.2)$$

where:

$NPARAB_{it}$ = new plantings of arabica trees in year t by farm i,

$NPROB_{it}$ = new plantings of robusta trees in year t by farm i,

$CONS_i$ = fixed effect estimate for farm i,

$WAGE_t$ = two year moving average of minimum wage of agricultural laborers in the plantation sector as set by government deflated by consumer price index at time t,

$PCOCOA_{t-1}$ = official producer price of cocoa deflated by the Yaounde CPI, and

$EGRA_t$, $EGRR_t$ = expected present gross revenue from new planting of an arabica (robusta) coffee tree at time t.

The new planting specifications necessarily neglect the influence of firm-specific variables, such as education, family size, capital stock, and cross-sectional differences in piece rates paid for agricultural labor, because the available observations on these variables are cross-sectional and if included in the regression would result in a linear dependence with the fixed firm effects. These variables were treated in regressions of the individual fixed effects.

A Model of Expected Gross Revenues

Both the equations estimated for replanting and new planting assumed producer behavior based on expectations of future revenues from the planting of a tree, which typically takes three years to begin producing

and then remains productive for thirty or more years. Due to a lack of data on labor and fertilizer costs, which comprise the major purchased inputs, discounted gross revenues were calculated. To approximate these expectations requires a device for modelling the farmer's forecast of price. The price forecasts were modelled for the nominal official producer price of coffee deflated by an index of consumer prices for the capital of Yaounde. The use of an urban price deflator introduced some misspecification as the bundle of consumer goods in the rural milieu does not exactly correspond to the urban, however, it was the best available indicator. Given the small country assumption, world price for the Cameroonian coffee industry was exogenous. Official producer price was also assumed exogenous. Producers were assumed to be aware of the stochastic process generating the time series of real producer price and responded to the conditional expectations of this time series.

Autoregressive price forecasting. Time series analysis of real producer prices for robusta and arabica from 1953 to 1992 was undertaken. Dickey-Fuller unit root tests indicated that both series were I(1) processes. Stationary autoregressive models of the first differences of these series were then evaluated according to two selection criteria and a test for 1st order serial correlation. The selection criteria used were:

(1) Akaike's minimum FPE criterion equal to:

$$FPE = \delta_p^2 \left(1 + \frac{1 + p}{n} \right)$$

where σ_p^2 is the estimate of the regression variance when the order of the autoregressive process is p; and

(2) A relative measure of R^2_D suggested by Harvey (1984):

$$R^2_D = 1 - \frac{RSS}{\sum_{t=2}^{T} (\Delta y_t - \overline{\Delta y_t})^2}$$

Harvey's R^2_D measures the residual variation of a model against the residual sum of squares from a random walk with drift, $y_t = y_{t-1} + \beta + \epsilon_t$, which can be considered the naive alternative for most non-stationary time series. A model for which $R^2_D < 0$ should be discarded. As Maddala (1992, p. 550) notes, for time series models with a strong trend the usual measure of R^2, which judges a model against the naive model of the mean of the dependent variable, is not very useful for evaluating the model specification. When the time series were regressed on a constant term and a time trend, the high R^2s, equal to 0.756 and 0.862 for robusta and arabica, respectively, might erroneously lead an acceptance of the models. However, the Harvey measure of R^2_D, equal to -1.358 and -1.864, indicates that neither model was very useful.

Initially, the models were estimated in first differences, however, the linear relationships in these models resulted in negative price forecasts particularly in more recent years. Clearly, producers would not expect prices to be negative. To capture the nonlinearity present in producers' price forecasts as real price declines, the data were transformed to natural logarithms. The specification criteria indicated an AR(1) process for both series (Table 3.2).

Table 3.2. Specification Criteria for Autoregressive Forecasting Models of Producer Price, 1953 to 1992.

Lag Order	Partial Autocor-relation	Harvey's Adjusted R^2	Akaike's FPE	Durbin's H	Chow Test 1988
Logarithm of Real Arabica Price, 1953-1992					
1	-0.1912	0.0408	0.0087	0.0329	9.2616
2	-0.1070	0.0053	0.0098	0.0219	8.4211
3	-0.1235	-0.0124	0.0107	-0.0418	7.9875
4	0.1459	-0.0205	0.0120	0.4145	0.0886
5	-0.1506	0.0138	0.0119	-0.7508	0.1047
6	-0.1157	-0.0566	0.0125	0.2672	0.1177
7	-0.2776	-0.0680	0.0134	0.5693	0.2590
8	0.1926	-0.1673	0.0157	0.1377	0.0618
9	-0.2051	-0.2220	0.0197	-0.0933	0.2823
10	-0.1719	-0.5873	0.0179	-3.1809	0.1549
Logarithm of Real Robusta Price, 1953-1992					
1	-0.0495	0.0025	0.0149	0.4018	12.412
2	-0.0416	-0.0331	0.0145	-0.5770	13.344
3	-0.0792	-0.0612	0.0153	0.3195	13.168
4	0.1686	-0.0683	0.0168	0.0058	0.0890
5	-0.1394	-0.1163	0.0192	0.1116	0.0946
6	-0.0336	-0.2259	0.0231	-0.2943	0.0931
7	-0.0473	-0.2371	0.0251	-0.2557	0.0593
8	0.1695	-0.3685	0.0322	-0.0922	0.0111
9	0.1594	-0.6581	0.0471	-0.3066	0.0286
10	0.4296	-0.6471	0.0426	0.1233	0.0630

Forecasts of expected future price require parameter stability and unbiasedness in prediction. A predictive test of stability is used to examine structural change,

$$F = \frac{(RSS - RSS_1)/n_2}{RSS_1/(n_1 - k - 1)}$$

which has an F-distribution with d.f. n_2 and $n_1 - k - 1$ (Chow, 1960). RSS is the residual sum of squares from the restricted regression based on $n_1 + n_2$ observations, and RSS_1 is the residual sum of squares from the unrestricted regression based on n_1 observations.

Two events hypothesized as eliciting a structural change of producer price forecasts were the impact of oil revenues from discoveries brought on-line in 1978 and the collapse in world price of coffee in 1988 and the subsequent reform of the marketing sector.[4] The Chow tests for the AR(1) models evaluated for the 1988 breakpoint (F-dist. (4,36) = 4.35) were above the 1% critical value for both series and rejected the null of parameter stability from 1988 to 1992 (Table 3.2). As for the 1978 breakpoint, the F-statistics were 0.7031 and 0.6237 for the arabica and robusta AR(1) models, respectively, and failed to reject the null hypothesis.

[4] The 1978 structural change hypothesis is that windfall revenues from oil royalties changed export pricing by the Presidency, i.e. lower margins between world price and the official producer price.

The forecast functions used to predict farmers' price forecasts were solved from the AR(1) models derived from the 1953 to 1988 data. Solving,

$$\ln P_t^{arab} - \ln P_{t-1}^{arab} = -0.0666 - 0.1912\ (\ln P_{t-1}^{arab} - \ln P_{t-2}^{arab})$$

$$\ln P_t^{rob} - \ln P_{t-1}^{rob} = -0.0531 - 0.0495\ (\ln P_{t-1}^{rob} - \ln P_{t-2}^{rob})$$

yields the forecast functions,

$$\ln \hat{P}_{T+f|T}^{arab} = 0.1912 \ln P_{T-1}^{arab} + \frac{\ln P_T^{arab} + 0.05591}{1.1912} + \left[\frac{\ln P_{T-1}^{arab} - \ln P_T^{arab} - 0.05591}{1.1912}\right](-0.1912)^f - 0.05591\, f \tag{3.3}$$

$$\ln \hat{P}_{T+f|T}^{rob} = \frac{0.0495 \ln P_{T-1}^{rob} + \ln P_T^{rob} + 0.0506}{1.0495} + \left[\frac{\ln P_{T-1}^{rob} - \ln P_T^{rob} - 0.0506}{1.0495}\right](-0.0495)^f - 0.0506\, f \tag{3.4}$$

Revision of these forecasts will directly impact on the level of expected discounted revenue from the new planting or replacement of a coffee tree.

Given the age-yield profile of a coffee tree and the subjective discount rate of the farmer, an estimate of the expected gross revenue stream from the planting of a coffee tree can be calculated. Using annual production data and information on the age of the plantation, empirical estimates of the age-yield relationship for both types of coffee were developed (Figures 3.1 and 3.2). The profile for robusta coffee was derived from 1,056 farm production records obtained from the extension office of the Ministry of Agriculture in the Moungo division (see Appendix B). These records supplied information on the date of creation for the plantation and the production for the years 1984 to 1988. The profile for

arabica, less precisely estimated due to fewer degrees of freedom, was derived from the data obtained in the 250 producer interviews.

Comparing figures 3.1 and 3.2, there was higher production over all age classes for robusta coffee. A lower decline in productivity for robusta coffee vis-a-vis arabica, as vintages approach 30 years was also noted. Part of the divergence in the two profiles was probably due to the indigenous nature of robusta coffee and its greater resistance to pests and disease problems. Also the farming system for arabica coffee incorporated a much higher degree and intensity of intercropping, which over time results in root damage to the coffee tree due to the cultivation practices of mainly female food producers.

These average profiles were combined with the price forecasts to estimate the expected discounted gross revenues from planting a tree over a twenty-three year time horizon assuming a constant discount rate,

$$EGRA(R)_{it} = \sum_{f=4}^{23} (\hat{P}_{t+f} Y_f) * (1 + r)^{-f} \qquad (3.5)$$

where P_{t+f} is the expectation in year t for real coffee price in year t+f, y_f is the expected yield in kilograms of a coffee tree of age f, and r is the constant subjective discount rate (= 0.20).

The value of the discount rate was chosen to reflect the opportunity cost of the farmer's own financial capital, and falls near the best rates

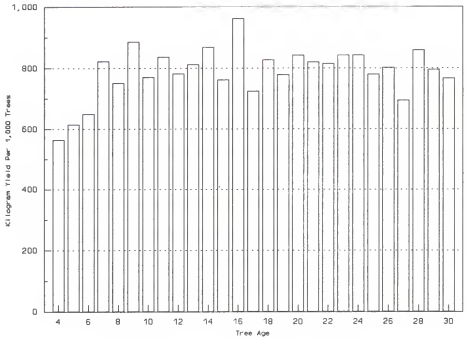

Figure 3.1. Age-Yield Profile for Robusta Coffee.

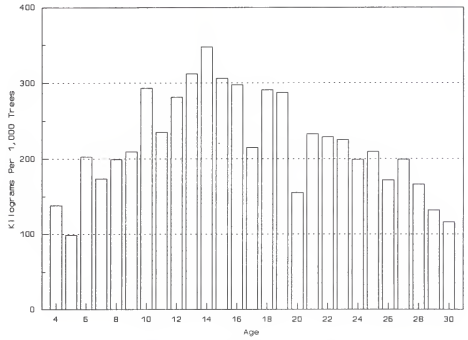

Figure 3.2. Age-Yield Profile for Arabica Coffee

available.[5] Twenty-three years was selected arbitrarily as the farmer's planning horizon, but given the discount rate assumed, revenues past 23 years add very little to total expected revenues.

Technological stagnation. The measure of expected gross revenues assumes that embodied technological progress has not occurred over the period of analysis (1970 to 1992). This assumption might be challenged for both the arabica and robusta sectors, where "improved" varieties have been available since the late 1970s and early 1980s. In the arabica sector the "Java" variety was introduced in the late 1970s in the West province by the cooperatives and in the early 1980s by MIDENO development parastatal in the Northwest Province. This variety is higher yielding than the traditional, when grown in pure stands with adequate application of fertilizers and pesticides. While a fair proportion of farmers were growing Java, analysis of variance on yields between the traditional and the Java variety did not indicate any difference in the sample. This may be attributed to the failure of those planting Java to implement the full set of recommended management practices, specifically, that of pure culture. All Java variety coffee farmers interviewed were inter-cropping with other food plants.

In the robusta sector, the major innovation has been the development of selected vegetatively propagated (VP) trees distributed through the Ministry of Agriculture from nursery production centers in the Southwest

[5] In the informal sector--specifically rotating savings groups in which many coffee households participate--the short-term real interest rates normally range between 60 to 144 percent per annum. Nominal interest rates from formal credit sources such as the cooperatives and the now defunct agricultural bank FONADER at the time of the study were mostly at the official ceiling on interest rates in the formal sector of 21 percent. Because of low inflation rates, these rates approach the real interest rate.

Province at Barombi Kang and in the East Province at Abong Mbang. However, among the 250 farmers interviewed, none had planted VP trees. Their nursery stock came from either their own seedling nurseries or from volunteer seedlings in established groves. Unlike arabica coffee, robusta coffee is strictly allogamous (cross-pollinating). This results in a great deal of genetic variation in seedling populations, indeed, a significant proportion may be nonbearing adults. The propagation of the best materials can only be carried out by vegetative means if it is desired to reproduce all the characteristics of the selected tree (Snoeck, 1988). VP stock retains parental traits and leads to the realization of significant yield gains. On-station mean yields of 12 elite clones produced at Barombi Kang and Abong Mbang ranged from 1,489 kg ha^{-1} to 3,137 kg ha^{-1} (Snoeck, 1988, p. 92). Robusta coffee groves planted with VP trees out-yield even the best seedling plots by 40-50 percent. The failure of farmers to adopt VP tree stock demands more research of both supply and demand factors in the adoption process.

Econometric Model Specification

There are two important characteristics of the small holder coffee sector, which must be accounted for in the econometric model. The first is the wide heterogeneity of the agricultural households. The second is the numerous corner solutions associated with observations showing no new planting decisions.

A serious potential bias in a pooled classical regression model using all observations arises when the assumption that y is generated by a common parametric probability distribution function is unrealistic. When a pooled model is inappropriately estimated, the direction of the

resulting bias in the pooled slope estimates can not be predetermined (Hsiao, p.6, 1986). The fixed effects model relaxes this assumption by allowing the intercept parameters to vary among firms. In the fixed effects model, time-invariant farmer specific heterogeneity is captured in the intercept variable. The firm's intercept accounts for the omission of variables such as environmental factors, managerial ability, infrastructural differences, and transaction costs. To accommodate the possibility of farm-level heterogeneity and corner solutions, the fixed effects Tobit model (Heckman and MaCurdy, 1982) was specified

$$\begin{aligned} y_{it}^{*} &= \beta_{oi} + \beta' x_{it} + u_{it} \qquad u_{it} \sim IN(0,\sigma^2) \\ y_{it} &= y_{it}^{*} \quad if\ y_{it}^{*} > 0 \\ &= 0 \quad otherwise \\ Let \quad d_{it} &= 1 \quad if\ y_{it}^{*} > 0 \\ &= 0 \quad otherwise \end{aligned} \tag{3.6}$$

The log-likelihood function is given by

$$\begin{aligned} \ln L = &\sum_{i,t} (1-d_{it}) \ln \Phi\left(\frac{-\beta_{oi}-\beta' x_{it}}{\sigma}\right) \\ &+ \sum_{i,t} d_{it}\left(-\frac{1}{2}\ln\sigma^2 - \frac{1}{2\sigma^2}(y_{it}-\beta_{oi}-\beta' x_{it})^2\right) \end{aligned} \tag{3.7}$$

Unlike the linear model where the fixed effects can be differenced out when estimating β and σ, in the Tobit version the fixed effects must be estimated. This presents a problem in terms of the consistency of the estimates as the fixed effects are only asymptotically consistent as t approaches infinity. The inconsistency of the fixed effects in small samples carries over to estimates of β and σ. Heckman and MaCurdy (1982) argue that the severity of this problem may not be great based on Monte Carlo experiments performed by Heckman (1979) with a multivariate fixed

effects probit model and $t = 8$. The maximum likelihood fixed effect model estimated parameter values very close to the true values. Honoré (1993), in Monte Carlo experiments with $t = 3$ for Tobit models with fixed effects and lagged dependent variables, also found that maximum likelihood estimates of the parameter estimates were close to the true values except for an underestimate of the parameter on the lagged dependent variable.

An additional problem likely to present itself given the cross-sectional dimension of the data set is heteroskedasticity. The presence of heteroskedasticity in a Tobit regression results in inconsistent estimates of the true parameters (Maddala and Nelson, 1975). The degree of inconsistency has been shown to depend on the amount of censoring in the model (Arabmazar and Schmidt, 1982). To correct for the bias, assumptions can be made about the nature of the heteroskedasticity and incorporated into the model. A reasonable assumption in a cross-sectional farm-level analysis is that the error variance is a function of the farm size, z_i, measured in hectares

$$\delta_i^2 = \alpha_0 e^{(\alpha_1 z_i)} \tag{3.8}$$

This expression can be substituted into the likelihood function to correct for the inconsistency introduced by the heteroskedasticity. The test of the null hypothesis of homoskedasticity can be based on a test of $\alpha_1 = 0$. If the heteroskedasticity assumption is correct, then a significant parameter estimate should result.

The first-order conditions for a maximum of the heteroskedastic log-likelihood function are:

$$\frac{\partial \ln L}{\partial \beta} = -\sum_{it}(1-d_{it})\frac{\phi x_{it}}{\sigma_i(1-\Phi)} + \frac{1}{\sigma_i^2}\sum_{it} d_{it}(y_{it}-\beta' x_{it})\,x_{it}$$

$$\frac{\partial \ln L}{\partial \alpha} = \left(\frac{1}{2\sigma_i^2}\sum_{it}(1-d_{it})\frac{\beta' x_{it}\phi}{\sigma_i(1-\Phi)}\right)\sigma_i^2 z_i - \left(\sum_{it} d_{it}\frac{1}{2\sigma_i^2} + \frac{1}{2\sigma_i^4}\sum_{it} d_{it}(y_{it}-\beta' x_{it})^2\right)\sigma_i^2 z_i$$

The second derivatives are:

$$\frac{\partial^2 \ln L}{\partial \beta \partial \beta'} = -\sum_{it}(1-d_{it})\frac{\phi_{it}}{\sigma_i(1-\Phi_{it})^2}\left[\frac{\phi_{it}}{\sigma_i} - \frac{1}{\sigma_i^2}(1-\Phi_{it})\beta' x_{it}\right]x_{it}x_{it}' - \frac{1}{\sigma_i^2}\sum_{it}(d_{it})\,x_{it}x_{it}'$$

$$\frac{\partial^2 \log L}{\partial \alpha \partial \beta} = -\frac{1}{2\sigma_i^2}\sum_{it}(1-d_{it})\frac{\phi_{it}}{\sigma_i(1-\Phi_{it})^2}\left[\frac{1}{\sigma_i^2}(1-\Phi_{it})(\beta' x_{it})^2 - (1-\Phi_{it}) - \frac{\beta' x_{it}\phi_{it}}{\sigma_i}\right]\sigma_i^2 x_{it} z_i' - \frac{1}{\sigma_i^4}\sum_{it} d_{it}\,(y_{it}-\beta' x_{it})\,\sigma_i^2 x_{it} z_i'$$

$$\frac{\partial^2 \log L}{\partial \alpha \partial \alpha'} = \frac{1}{2\sigma_i^2}\sum_{it}(1-d_{it})\frac{\beta' x_{it}\phi}{\sigma_i(1-\Phi)}\sigma_i^2 z_i z_i' - \sum_{it} d_{it}\frac{1}{2\sigma_i^2} + \frac{1}{2\sigma_i^4}\sum_{it} d_{it}(y_{it}-\beta' x_{it})^2\sigma_i^2 z_i z_i' + \frac{1}{4\sigma_i^4}\sum_{it}(1-d_{it})\frac{\phi_{it}}{\sigma_i(1-\Phi_{it})^2}\sigma_i^2 z_i z_i' \left[\frac{1}{\sigma_i^2}(1-\Phi_{it})(\beta' x_{it})^3 - 3(1-\Phi_{it})\beta' x_{it} - \frac{(\beta' x_{it})^2\phi_{it}}{\sigma_i}\right] + \left[\frac{1}{2\sigma_i^4}\sum_{it} d_{it} - \frac{1}{\sigma_i^6}\sum_{it}(d_{it})(y_{it}-\beta' x_{it})^2\right]\sigma_i^2 z_i z_i'$$

These derivatives were used in conjunction with Newton-Raphson algorithm to solve for the maximum likelihood estimates. The software used was the MAXLIK module of GAUSSI.

Maximum Likelihood Results

The estimation was a two-step procedure. In the first step, the heteroskedastic fixed effects model was applied to the new planting functions in equations 3.1 and 3.2 and estimated by the method of maximum likelihood for the period 1970 to 1992. Although there were data on new plantings prior to 1970, this date was chosen as the starting point for the analysis because of the difficulty in controlling for the civil unrest, which characterized much of the coffee growing area following independence. The second step consisted of regressing the estimated fixed effects for each firm on various firm-specific variables, either time-invariant or the means of time-varying factors.

Table 3.3 reports the sets of estimates for arabica and robusta producers for the fixed effects Tobit model. The signs were in accordance with the hypothesized effects. The relationship between the error variance and farm size (measured in hectares of total farmland) was positive and significant, and rejects the null of homoskedasticity. Larger farms were associated with larger error variance of new planting. The effects of expected revenue were significantly positive in both regressions. The lagged real price of cocoa had a significant negative effect on robusta new plantings. This result was consistent with cocoa revenues as an indicator of the opportunity cost of creating new coffee lands.

The wage variable was not significantly negative in either regression. The result was not surprising, for, although labor costs are the most significant costs incurred in terms of production and a major adjustment cost, it is unlikely that they were well represented by a wage

Table 3.3. Maximum Likelihood Estimates of New Planting Model, 1970-92.

Parameters	Arabica	Robusta
$EGRA_t$--present value of expected gross arabica revenues	16.4 (6.77)	...
$EGRR_t$--present value of expected gross robusta revenues	...	21.7 (5.15)
$PCOCOA_{t-1}$--real cocoa price	...	-12.1 (-2.01)
$WAGE_t$--minimum wage in industrial plantation sector	-4.74 (-0.901)	-0.721 (-0.163)
Variance intercept	5.70 (29.2)	4.78 (25.0)
Variance parameter on farm size	0.732 (5.07)	0.748 (4.74)
Mean - fixed effects	-51.4	-30.6
Std dev - fixed effects	17.1	9.79
Total observations	3,496	2,875
No. of limit observations	3,224	2,549
Log likelihood value	-1,852.51	-1,946.50
Number of farms in analysis	152	125

Note: Asymptotic t statistics are in parentheses.

proxy from the plantation sector. First, there appears to have been a good deal of between-farm variation in the actual piece rates paid to seasonal agricultural workers.[6] Although some of this variation was explained by differences in the difficulty of the piece work, a certain portion was probably due to the varying labor supply conditions likely to result from relatively poor communications infrastructure. Moreover, in many coffee households the labor adjustment cost of new plantings would be

[6] The variation in piece rates paid (the dominant type of contractual arrangement) was relatively greater in the arabica sector where the coefficients of variation for weeding, pruning and harvesting were 0.65, 0.76 and 0.32 versus 0.42, 0.36 and 0.41 for the robusta sector during the 1991/92 coffee season.

reflected in changes in the shadow wage of household labor. In addition, the actual adjustment cost may not be large if the farmer has his own nursery.

To evaluate the magnitudes of the effects of the independent variables on the observed dependent variable, elasticities were calculated as (Maddala pp. 157-60, 1983)

$$\eta_{jit} = \frac{\Phi(z_{it})\,\beta_j\,\bar{x}_j}{\Phi(z_{it})\,\beta' x_{it} + \sigma_i \phi(z_{it})} \tag{3.9}$$

where η_{jit} is the calculated elasticity of new plantings with respect to variable j for farm i at time t, and z_{it} is equal to $\beta' x_{it}/\sigma_i$. Because of varying fixed effects, the elasticities differed among farms for a given expected value of the independent variable. The mean and standard deviation of the $n*t$ calculated elasticities are presented in Table 3.4.

The average elasticity of observed new plantings to expected gross revenues for the robusta sector was quite elastic with a value of 3.04. This was nearly double that of the arabica sector. An obvious explanation lies in the relative land surplus of the robusta sector. With land pressures in some arabica growing areas approaching 300 inhabitants km^{-2}, farmers are constrained from bringing new land into production. In the robusta sector, the opportunity costs of bringing new land into production were lower and the potential coffee land of a higher quality and therefore the responsiveness to price was greater.

Robusta new plantings were also quite responsive to the lagged real price of cocoa. The interrelationship between the two sectors was strong, especially in the Southwest Province where cocoa production in recent years has increased, as the relative price of cocoa improved in the last

Table 3.4. Mean Elasticity Estimates of New Planting Model, 1970-92.

Elasticity w/r/t	Arabica	Robusta
$EGRA_t$	1.584 (0.4498)	...
$EGRR_t$	...	3.039 (0.8666)
$PCOCOA_{t-1}$	...	-1.691 (0.4821)
$WAGE_t$	-0.4590 (0.1303)	-0.1010 (0.02880)

Note: Standard deviations of mean are in parentheses.

15 years. A similar relationship has been noted for the case of cocoa and coffee in Côte d'Ivoire (Akiyama and Trivedi, 1992).

Fixed Effects Regression

When producer- and farm-specific variables that do not vary with time are included in the fixed effects model given in equation 3.6, these variables and the firm-specific dummy variable will be perfectly correlated (Hsiao, p. 50, 1986). However, their effects can be consistently estimated, when the number of firms tends towards infinity, by regressing the firm fixed effects on these variables. This step is of considerable interest for variables such as the depreciation value of the capital equipment stock, labor piece rates, and family size, which were not gathered across all time periods. Assuming static ratios of these variables among farms, then their inclusion in a regression of the fixed effects can give an indication of their effect.

The results of the regression of the fixed effects are presented in Table 3.5. The nonlinear effect of producer age (*AGE*) on new plantings was evident in both regressions; the F-statistics for the joint null

hypotheses of no effect for age and its quadratic were 5.07 and 3.72 for robusta and arabica, respectively. The relationship between new planting and the age of the producer reflects a diminution of the planning horizon with age. The significant negative effects of the quantity of fertilizer (*FERT*) in both cases were indications that increased fertilizer levels served as substitutes for new plantings by increasing the desired output of the firm.

FAMILY SIZE, measured as total number of persons living in the household, had a significant positive effect on robusta, but was negative although not significant in the case of arabica. The difference in results between the two sectors might be explained by the relatively higher ratio of farm hectares per worker in the robusta sector, where surveyed farms were on average 1.2 hectares larger than those in the arabica sector, and the family size was slightly smaller. As such the marginal productivity of a family worker should be higher in the robusta sector. The insignificance in the arabica sector may also reflect more of a reliance on hired labor markets.

CAPITAL, an estimate of the annual depreciation value of the capital equipment stock in 1992, was positive in both sectors though only significant in the arabica (see Appendix A, p. 165). The expected value of a newly planted tree will be greater the higher the capital input. The education dummy (*EDUCATION*) measures those producers with 4 or more years of formal education. In neither case was it significant.

The effect of *FARM SIZE* measured in hectares was negative and of a similar magnitude for both sectors. The explanation for this result may lie in higher costs of adjustment for large farms versus smaller farms

Table 3.5. OLS Regression of Fixed Effects from New Planting Model for Arabica and Robusta Coffee on Time-Invariant Variables.

Variable	Arabica Parameter Estimate	Robusta Parameter Estimate
INTERCEPT	-51.92	-26.33
NORTHWEST dummy	2.417 (1.233)	...
PRODUCER AGE (years)	0.8441 (1.913)	0.3889 (1.000)
AGE^2	-0.0094 (-2.241)	-0.0056 (-1.475)
FAMILY SIZE (mean of 1983-1992)	-0.1321 (-1.158)	0.1789 (1.974)
MAIZE dummy (= 1, if maize grown in intercrop)	-1.196 (-0.7162)	...
FERT (kilograms of nutrients/1,000 trees)	-0.03891 (-1.999)	-.00963 (-1.503)
CAPITAL (annual depreciation of capital stock)	0.000051 (1.357)	0.000037 (1.120)
EDUC dummy (= 1, if years of schooling ≥ 4)	2.046 (1.071)	-1.198 (-0.7994)
QFEASIBLE (mean kilograms, 1970- 1992)	0.00519 (2.630)	-.000581 (-1.252)
FARM SIZE (total hectares)	-3.764 (-14.14)	-1.548 (-7.974)
Valid cases	145	111
Condition number	22.61	18.31
Adjusted R^2	0.700	0.603

Note: T-ratios are in parentheses

where the use of mainly family labor reduces these costs. The measurement of *FARM SIZE* was error-ridden as most farmers were without title to their land and could only estimate their farm size.

The variable, *QFEASIBLE*, measures the average potential output of the farm from 1970 to 1992 calculated from a farm's tree stock, its age

distribution, and the empirical age yield profiles above. The *a priori* expectations were negative; a farm with a low potential production would be expected to be relatively more inclined to undertake new plantings. The results were mixed; in the robusta sector a weak negative effect was found, while the arabica sector showed a significantly positive, but small effect.

A Model of Coffee Replanting

In recent efforts by other researchers replanting equations have been posited as functions of lagged current real price, expected future price, lagged average revenue, real interest rates, and some measure of the distribution of the tree stock (Hartley, Nerlove, Peters, 1987; Trivedi, 1992). The analysis here takes a similar approach with differences mainly in the use of the measure of expected gross revenues developed above to model the price and technology effects, rather than simply lagged prices. Trivedi posited that increases in the real price of cocoa affected cocoa replantings negatively by inhibiting uprooting of formerly uneconomic stock (high prices transform uneconomic stock to be replanted into economic stock) and positively through its impact on lagged average gross revenues (price times yield), which was his proxy for expected discounted revenues. In the small holder sector of Cameroon such a scenario is less likely for several reasons. Among the farmers replanting, 87 and 70 percent of robusta and arabica producers indicated that a major reason they replanted was to replace dead or dying trees, while only 27 and 39 percent indicated that a major reason was because the trees were no longer productive due to old age. These farmers were more likely to respond to long-run expectations of price in a fashion similar

to new planting behavior. Rising prices and/or an increasing yield profile of the coffee tree result in rising revenue expectations and provides the incentive to pull the dead and diseased trees out of the orchard for replacement, when revenue expectations are stagnant or declining farmers will not have an incentive to replace these trees. A relatively high discount rate among small holders will also tend to dampen a negative short-run price effect. For these reasons, lagged current prices are not entered directly into the model estimated for replantings. The effect of near term prices enters through the AR(1) model of coffee producers' price expectations used in the calculation of expected gross revenues.

The replanting functions for arabica and robusta coffee were,

$$RPARAB_{it} = f(CONS_i, EGRA_t, TR_AG20_{it}) \tag{3.10}$$

$$RPROB_{it} = f(CONS_i, EGRR_t, TR_AGE20_{it}) \tag{3.11}$$

where:

$RPARAB_{it}$ = number of arabica trees replanted in year t by farm i,

$RPROB_{it}$ = number of robusta trees replanted in year t by farm i,

$CONS_i$ = fixed effect estimate for farm i,

$EGRA_t$, $EGRR_t$ = expected present gross revenue from the replanting of an arabica (robusta) coffee tree at time t, and

TR_AG20_{it} = number of trees of age greater than 19 years.

EGRA and *EGRR*, which proxy the producer's price and yield expectations from the planting of a new tree, were expected to be positively related to the level of replantings. *A priori*, it was expected that the relatively more mature arabica industry would be more responsive to a change in

revenue expectations, than the younger robusta industry where land pressures were lower.

There are other than economic considerations in the determination of coffee replantings. Disease, drought, and brush fires add a random element to replanting levels. Where coffee is grown in an intensive maize and bean inter-crop system, as in the densely populated coffee growing regions of the West and Northwest Province, cultivation around the coffee roots can considerably shorten the life expectancy of the average coffee tree. While it was difficult to control for the effects of micro-climatic differences, brush fires and variations in the intensity of the inter-cropping, the impact of age on the increased likelihood of replanting was addressed by the inclusion of *TR_AGE20*. As the tree ages, susceptibility to disease increases. The number of trees over the age of twenty years was expected to be positively related to the level of replantings.

Maximum Likelihood Results

The heteroskedastic version of the fixed effects Tobit model (equation 3.6) was used to estimate equations 3.10 and 3.11 again under the assumption that the heteroskedasticity was a function of farm size. The models were estimated for 1985-92. The data on replantings were from the producer interviews and were based on farmer recall, as written records of replantings were not available. Only farms with complete observations over the 8 years were analyzed. The combination of these two conditions reduces the degrees of freedom significantly in the model as compared to the new planting model.

Table 3.6 presents the fixed effects model results for the two sectors. The relationships between the error variance and farm size

Table 3.6. Maximum Likelihood Estimates of Replanting Model, 1985-92.

Parameters	Arabica	Robusta
$EGRA_t$--discounted expected gross arabica revenues	1.618 (2.952)	...
$EGRR_t$--discounted expected gross robusta revenues	...	0.6448 (3.839)
$TR_AGE_{20,t}$--trees of vintage ≥ 20 years	0.1449 (0.4615)	-0.4178 (-1.552)
Variance intercept	2.344 (16.34)	0.1883 (1.479)
Variance parameter on farm size	0.4078 (3.375)	0.5781 (6.114)
Mean - fixed effects	-2.985	0.3979
Std dev - fixed effects	2.247	1.679
Total observations	640	480
No. of limit obs.	328	140
Log likelihood value	-1030	-709.1
Number of farms	80	60

Note: Asymptotic t statistics are in parentheses.

(measured in hectares of total farmland) were positive and significant, and rejected the null of homoskedasticity. Larger farms were associated with a larger error variance of replanting. The measure of gross expected revenues was significantly positive in both regressions and of greater magnitude in the arabica sector. In the robusta sector, *TR_AGE20* was negative, but is not significant at conventional levels.

The elasticity estimates of the responsiveness of observed replantings to discounted expected revenues were larger for the arabica sector, reflecting of the relative land scarcity in the arabica industry, where greater adjustment occurs on the intensive margin (Table 3.7).

Table 3.7. Mean Elasticity Estimates of Replanting Model, 1985-92.

Parameters	Arabica	Robusta
$EGRA_t$	0.6010 (0.1680)	...
$EGRR_t$	...	0.5120 (0.2050)
TR_AGE20_{it}	0.05383 (0.01504)	-0.3318 (0.09558)

Note: Standard deviation of mean in parentheses.

Fixed Effects Regression

Although *TR_AGE20* was not significant in the fixed effects Tobit model, when the fixed effects from the Tobit model were regressed tree age had a positive and elastic effect in the robusta sector. Among the other variables analyzed only the rate of fertilizer applied (*FERTILIZER*, measured as the mean rate applied per 1,000 trees from 1988 to 1992) and the size of the farm were significant (Table 3.8). The fertilizer variable was positive in both regressions, which contrasts with the results for fertilizer in the new planting fixed effects regression. In the latter, the fertilizer effect was interpreted as reflecting a substitute relationship; in the case of replantings, farmers with land constraints who apply higher rates of fertilizer would have a expected return from replanting. The measure of farm size was positive for robusta and negative for arabica. The difference in signs between the two estimates is difficult to interpret. A possible conjecture is that the scope of alternative farm enterprises (e.g., poultry and horticultural production) in the robusta growing area is less than in the arabica area and participation in these activities is positively related to the size of

Table 3.8. OLS Regression of Fixed Effects from Replanting Model on Variables that Remained Fixed over the Sample Period, 1985-92.

Variable	Arabica Parameter Estimates	Robusta Parameter Estimates
INTERCEPT	-7.548	-1.378
EDUC (years of schooling)	-0.1090 (-1.165)	0.06127 (1.081)
PRODUCER AGE (years)	0.1829 (0.8824)	-0.0176 (-0.150)
AGE^2	-0.0018 (-0.9949)	0.000300 (0.2818)
FAMILY SIZE (mean size, 1985-92)	0.02719 (0.7788)	0.002244 (0.06544)
CAPITAL (annual depreciation of capital stock in 1992)	-0.000004 (-0.3267)	-.000009 (-0.7252)
WAGE (average cost per 1,000 trees, 1988 and 1992)	0.000003 (0.1041)	0.00004 (0.1850)
TR_AGE20 (mean trees of vintages ≥ 20 years, 1985-92)	0.000181 (0.5070)	0.000772 (3.012)
FERTILIZER (mean kilograms of nutrients/1000 trees, 1988-92)	0.01597 (2.486)	0.006544 (2.899)
FARM SIZE (total hectares)	-0.1692 (-2.971)	0.08822 (2.272)
Valid cases	74	55
Condition number	24.79	23.34
Adjusted R^2	0.072	0.388

Note: T-ratios are in parentheses.

the farm, therefore larger farmers in the arabica area tend to be less inclined to replant their coffee.

Short-Run Supply

Having examined the investment behavior affecting the farmer's tree stock, the supply model is closed by the short-run supply equation. The short-run response of the producer occurs through the adjustment of the

variable factors of production in response to disequilibria generated by a divergence between the expectation and realization of the exogenous variables. The major variable factors in the short-run are fertilizer, pesticides, prices of alternative cash crops and labor inputs.

To estimate the short-run response over time, the model must control for the changing flow of output from the capital tree stock due to the vintage effect. An empirical measure of this vintage effect is provided by the age-yield profiles presented in figures 3.1 and 3.2 and information on the age distribution of the farmer's trees. Deviations from this flow of output occur because of stochastic elements such as weather, civil disturbances such as those following independence in the Littoral and the West Provinces, and the deviation of current prices from their expected levels. As already discussed, there was an unprecedented downward adjustment in the prices of coffee in the 1988/89 season (robusta from 440 to 175 and arabica from 475 to 250 FCFA). From independence, there had only been two other nominal downward adjustments in coffee prices, the most recent being in 1965 for robusta coffee (from 127 FCFA to 100 FCFA) and 1971 for arabica (from 155 to 145 FCFA). A determination of the magnitude of short-run producer response to this unexpected deviation in the real producer price is one of the objectives of this analysis.

In addition to the price decline in the output market; the fertilizer market has been the focus of liberalization efforts since 1988. Prior to 1988, fertilizer was imported and subsidized at rates approaching 60 percent. However, given a limited willingness to import, the quantity demanded typically exceeded the quantity procured and, as a result, an illegal market for fertilizer developed. Since 1988, the Cameroon

government no longer subsidizes the import of fertilizer and has initiated privatization of the sector. Not surprisingly, the liberalization of the fertilizer market was the first reform undertaken by the government with regards to the coffee sector, reflecting a weak level of political influence on the part of small holder coffee producers. To ease the transition of the privatization efforts, USAID has assisted in providing financing for a gradual subsidy phaseout. The result has been gradually increasing fertilizer prices and as a result of these increases and the decrease in the price of coffee, a significantly decreased demand by the coffee sector.

Given the above considerations the general forms of the models estimated for the robusta and arabica sectors were:

$$QROB_{it} = f(CONS_i, PCAFE_{it}, PCAFE_{it-1}, PFERT_{it}, POTHER_t, QFEASIBLE_{it}) \quad (3.12)$$

$$QARAB_{it} = f(CONS_i, PCAFE_{it}, PCAFE_{it-1}, PFERT_{it}, POTHER_t, QFEASIBLE_{it}) \quad (3.13)$$

The price of coffee was officially set for each campaign by the National Produce Marketing Board in both sectors (Table 3.9). Normally the current price was announced in December at the beginning of the harvest season. For this reason, lagged and current price were included in the formulation. The current price will affect the harvesting decision of the producer while the price from the previous campaign will provide the information upon which application of the variable inputs will be based. Though the announced official price was a pan-territorial price, the

Table 3.9. Official Producer Price and Mean Realized Prices by Province in Cameroon Coffee Sector, 1988-92.

	Arabica Prices			Robusta Prices		
Year	Realized Price West	Realized Price NW	Gov't Price	Realized Price Littoral	Realized Price West & SW	Gov't Price
1988	520 (0.00)	511.4 (60.3)	520	432.3 (45.0)	434.4 (49.8)	440
1989	475 (0.00)	451.8 (74.1)	475	384.9 (116.0)	396.0 (105.0)	440
1990	248.5 (19.5)	247.1 (27.0)	250	165.2 (34.2)	174.9 (1.30)	175
1991	248.4 (19.6)	244.0 (35.5)	250	150.8 (24.4)	148.9 (27.5)	155
1992	249.9 (1.90)	228.7 (65.7)	250	148.8 (23.9)	146.7 (34.1)	155

Note: Standard deviations are in parentheses.

varying incidence of payment arrears from 1988-92 resulted in between-farm variation in the actual price realized by producers, $PCAFE_{it}$.[7]

The fertilizer price variable, $PFERT_{it}$, is constructed as FCFA per kilogram of available nutrients. Fertilizer prices per sack were often constant across farms regardless of their nutrient analysis. For example, while 50 kilogram bags of ammonium sulfate and urea typically sold for the same price, there is more than twice the amount of available nitrogen in the urea fertilizer. To account for this variation as a rational producer would, the price of fertilizer in the analysis was the per bag price divided by the total kilograms of available N-P-K nutrients per 50 kg bag, i.e., the price per kilogram of nutrient. Since farms varied by types of

[7] In the robusta sector, 55 percent of the farmers interviewed in 1992 were still owed, either by cooperatives or licensed buying agents, an average amount of 434,131 FCFA for coffee delivered in previous seasons. In the arabica sector, 29 percent were owed an average amount of 98,247 FCFA.

fertilizers applied there is substantial variation in this price between farms. A rural consumer price index (CPI) was used to deflate the nominal prices of fertilizer and coffee. This rural CPI was obtained from the price series used to compute the Yaounde consumer price index (the only CPI existing) weighted by rural expenditure patterns obtained from the household consumption survey of 1983-84 (MINPAT, 1989).

Other variable inputs of importance were pesticides. The two major pests of arabica coffee, which reduce yields significantly, are anthracnose (*Collectotrichum coffeanum*, a fungal disease causing berries to drop) and antestia (*Antestiopsis* spp. an insect, which bores into the coffee berry). Anthracnose is also a problem with robusta coffee, but to a lesser extent. Prior to the collapse of the ONCPB the farmer was supplied with insecticides at no cost. There were also "anthracnose brigades" of the Ministry of Agriculture, which would apply copper fungicides on a farmer's field with only the fuel cost to run the thermonebulizer paid by the farmer. Because of the downturn in world coffee prices and the budget crisis of the late 1980s, the government ceased its activities in these areas. Since 1989, the limited farmer demand for pesticides has been met by private farm chemical suppliers who until the collapse of government intervention in the coffee market focused most of their attention on the growing horticultural crops industry of the Western highlands area. Unfortunately, price data on these chemicals were not obtained and the pesticide effect is one of the omitted variables captured in the farm's fixed effect.

POTHER, was an index of the annual mean provincial prices of alternative cash crops weighted by the proportion of farmers in each

division ranking the crop as either the most important or second most important cash crop alternative to coffee. The commodities included in the index were cocoa, oil palm and plantains for the robusta sector, while for the arabica sector, they were maize, plantains, beans, taro-cocoyams, and potatoes. The expected sign of its coefficient was negative.

$QFEASIBLE_{it}$ was calculated by combining the empirical age-yield profile of the tree with the information on the age distribution of the farmer's tree stock,

$$QFEASIBLE_{it} = \sum_{a=4}^{31^{+}} y(a) \cdot NT(a)_{it} \qquad (3.14)$$

where $y(a)$ is the yield of trees of age a (unsmoothed except that the first three years were set to zero), and $NT(a)_{it}$ gives the number of trees of age a on farm i in year t. Its coefficient was expected to be equal to one.

The age-yield profiles, which were constructed based on farmer sampling, average out the effects of the biennial bearing cycle noted in the agronomic literature.[8] At the micro-level a satisfactory method of modeling the biennial bearing effect was not devised.

The precision of the calculation of $y(a)$ is greater for robusta coffee because of a larger number of degrees of freedom. To accurately calculate the relationship between age and yield requires observations where the yield data are specific to a given age class. The robusta age-yield profile was calculated using farm production records obtained from the extension service of MINAGRI in Melong II. One thousand and fifty-six

[8]Evidence of the biennial bearing cycle was found in the farmer production records obtained from MINAGRI.

records indicating a single date for the establishment of the plantation were selected (from among approximately 5,000 total booklets). To calculate $y(a)$ for arabica coffee, only the information in the producer survey was available and a single establishment year criterion could not be used, as doing so would have reduced significantly the number of observations.

In order to increase the degrees of freedom in calculating the mean yield per age class for arabica, a 3 year moving range of the establishment years was used to calculate the average for the center year in the age class. For instance, to calculate the average yield of trees of 20 years of age in the year 1980, the 1980 production on all coffee plantations established from 1959 to 1961 were included in the average. For 1981, those plantations established from 1960 to 1962 were used. An additional difference in the calculation of the two profiles was the production period used to calculate the average. Production data in the survey were gathered from 1978 to 1992, the production data in the MINAGRI robusta records were from 1984 to 1988.

Maximum Likelihood Results

The heteroskedastic version of the fixed effects (noncensored) model was used to estimate equations 3.12 and 3.13. The likelihood function was given by

$$Ln\ L = \sum_{i,t}\left\{-\frac{1}{2}\ln\sigma_i - \frac{1}{2\sigma_i^2}(y_{it}-\beta_{0i}-\beta'x_{it})^2\right\} \qquad (3.15)$$

Where σ_i^2 remains as defined in equation 3.8. The individual fixed effects are then regressed on time-invariant firm-specific variables as well as

the mean of feasible production over the sample period. For comparative purposes, pooled cross-sectional OLS was also used to estimate equations 3.12 and 3.13 and the results can be found in Appendix C. All variables including the dependent were normalized by dividing through by their means.

The fixed effects model results are presented in Table 3.10. The relationship between the error variance and farm size (measured in hectares of total farmland) was positive and significant, and rejects the null of homoskedasticity. Larger farms were associated with a larger error variance of production. The qualitative effects of the other variables were as hypothesized with the exception of lagged price for arabica coffee.

The results indicated a significant and positive response to current price for both arabica and robusta. The response to lagged price was negative, but not significant for arabica and positive and significant for robusta. The short-run elasticities to short-term shocks in real producer price were inelastic in both cases, but more so in the robusta sector.

The estimate of $QFEASIBLE_u$ was close to zero for the robusta sector. There was, however, a strong relationship between $QFEASIBLE_u$ and the fixed effects in the regression of the fixed effects. The estimate of *QFEASIBLE* for arabica coffee was significant at the 10 percent level.

Fertilizer price was negative in both sectors although its coefficient was only significant in the robusta sector. The impact of *POTHER* was negative in both equations and significant in the case of robusta, indicating competition for household resources by cocoa, plantains and oil palms.

Table 3.10. Maximum Likelihood Estimates of Short-Run Supply Model, 1988-92.

Parameters	Arabica	Robusta
$PCAFE_{it}$ (realized producer price deflated by rural cpi)	0.4288 (2.204)	0.1998 (2.420)
$PCAFE_{it-1}$	-0.09147 (-0.4925)	0.1504 (2.773)
$QFEASIBLE_{it}$ (feasible or expected output)	0.6352 (1.643)	0.04629 (0.1790)
PFERTit (FCFA per kilogram of nutrient deflated by rural cpi)	-0.04443 (-0.4293)	-0.2077 (-1.789)
$POTHER_t$ (price index of alternative cash crops deflated by rural cpi)	-0.1080 (-1.178)	-0.3682 (-1.963)
Variance intercept	-1.822 (-8.519)	-3.336 (-25.49)
Variance parameter on farm size	2.276 (11.05)	1.433 (12.24)
Mean - fixed effects	0.1433	1.179
Std dev - fixed effects	1.365	1.191
Total observations	700	585
Log likelihood value	-1131	-273.5
Number of farms	140	117

Note: Asymptotic t-ratios are in parentheses.

Fixed Effects Regression

The *WAGE* variable was constructed as the annual wage bill for the weeding, pruning, fertilizing and harvesting of 1,000 trees based on the piece rates paid for these tasks for the 1992 season and for the 1988 season, (prior to the price fall). The average of these two rates was used. Its effects were in neither case significant. While labor costs represent the most significant implicit cost, in latter years the proportion of farmers using hired labor fell significantly.

Table 3.11. OLS Regression of Fixed Effects from Short-Run Supply Model for Arabica and Robusta Coffee.

Variable	Arabica Parameter Estimates	Robusta Parameter Estimates
INTERCEPT	-0.4844 (-1.021)	-1.545 (-2.157)
JAVA (ratio of Java to all trees)	-0.3569 (-0.7226)	...
FARM SIZE (total hectares)	-0.0474 (-1.034)	...
QFEASIBLE (mean value 1988 to 1992)	-.00009491 (-0.3436)	0.0002837 (8.789)
FERTILIZER (mean kilograms applied 1988-92)	0.01092 (3.523)	0.004462 (6.863)
FAMILY SIZE (mean size, 1988-1992)	0.02867 (1.867)	0.01690 (1.228)
EDUC (number of years schooling of producer)	-0.01256 (-0.3276)	0.02118 (1.324)
WAGE (estimated wage bill per 1000 trees at 1988 and 1992 piece rates)	-0.00001178 (-0.9063)	0.008425 (0.8985)
CAPITAL (annual depreciation of capital stock, 1992)	0.000008282 (1.380)	...
LITTORAL dummy (= 1, if Littoral Province farm)	...	1.140 (2.228)
WEST dummy (= 1, if West Province farm)	...	0.8396 (1.642)
Northwest dummy (= 1, if Northwest Province farm)	0.8030 (2.648)	...
Number of Observations	130	103
Condition number	13.22	26.59
Adjusted R^2	0.093	0.615

Note: Student's t-ratio are in parentheses.

Although insignificant in the fixed effects model, *QFEASIBLE* had a strong positive effect on the level of the fixed effects in the case of

robusta and thereby on the level of output as predicted by the model. At the mean the elasticity was 0.70.

CAPITAL measured the annual depreciation of the capital stock existing in 1992. The results for this variable in the arabica sector exhibited a positive effect on the level of fixed effects. As expected producers with more capital had a higher level of production.

FAMILY SIZE measured the total number of persons living in the household. Positive and significant marginal products of family labor were implied by the parameter estimates for *FAMILY SIZE* in the arabica sector. In the robusta sector it was positive, but only significant at the 12 percent level.

As discussed previously the adoption of the "Java" variety of arabica coffee does not appear to have had a significant effect on yields. This hypothesis was supported by the insignificant and negative coefficient on *JAVA*, which measures the proportion of a farmer's plantation consisting of the Java variety.

Regional dummy variables indicate that the Northwest is more productive in arabica production than the West Province.[9] In the robusta sector the dummy variables indicate a ranking of Littoral, West and Southwest in terms of productivity. This is in accordance with expectations, the Littoral Province is favored by rich soils and a relatively developed infrastructure; the West Province by a better infrastructure, but relatively poorer soils; and the Southwest by medium to high quality soils, but poor infrastructure.

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[9]Although the West province has a better developed infrastructure, the North West in general has the better soils.

EDUC, which measures the number of years of schooling, had a positive effect, significant at the .10 level, in the robusta sector and a negative though insignificant effect in the arabica sector. The importance of education on production in the robusta sector may be more pronounced because of the larger size of enterprises in this sector. The mean years of schooling in the robusta sector were double that of the arabica sector, and the potential production, *QFEASIBLE*, which indicates the size of the commercial enterprise was nearly five times that of the arabica sector.

The effect of *FERTILIZER* was significant and positive in both regressions. Although its price was included in the short-run supply function, the significant effect here indicates that the farm-level demand for fertilizer was also a function of other than coffee and fertilizer price. Other factors may include varying degrees of credit constraints at the farm-level as well as possibly inadequate supplies. The evidence from the fixed effects data was that intercropping coffee farming systems were responsiveness to fertilizer application.

Fertilizer Demand in the Coffee Sector

As the short-run supply model indicated, the effect of fertilizer application on coffee production was strong. The farmer's demand for fertilizer as a function of price and other factors was investigated. The general functional form can be written as

$$QFERT_{it} = f(CONS_i, PCAFE_{it-1}, PFERT_{it}) \qquad (3.16)$$

The dependent variable, *QFERT*, was defined as the annual kilograms of fertilizer nutrients (N, P, K) applied per tree of bearing age (age > 3

years) multiplied by 1,000. The dependent variable was, thus, the annual amount of fertilizer nutrients applied per 1,000 trees, which is approximately equal to 1 hectare of coffee holdings in the robusta sector and slightly less than 1 hectare in the arabica sector, where the planting densities are higher on average. Because the dependent variable was normalized by the number of trees, the measure of feasible output was excluded from the specification. The independent price variables were defined as in the above model of short-run supply. Fertilizer was considered to be a normal input such that an increase in the price of coffee will result in an increase in the demand for fertilizer. The specification does not include *POTHER* as preliminary regression models did not indicate a significant effect.The efficiency of the estimates would benefit from joint estimation of the short-run supply function, however, the complexity of the model specification hinders its estimation.

Maximum Likelihood Results

The heteroskedastic version of equation 3.6 was used to estimate equation 3.16 for both sectors. The period of estimation was from 1988 to 1992. Prior to 1988, subsidized fertilizer quantities were not sufficient to meet demand. Under these conditions, the price-quantity observations would not be on the derived demand schedule. Since the liberalization of the fertilizer markets beginning in 1988, positive carry-over stocks have been reported at the wholesale level indicating equilibrium quantities were available at the farm level (Abbot and Lloyd, 1992).

The results of the estimation are reported in Table 3.12. As with the other models, the relationship between the error variance and farm size (measured in hectares of total farmland) was positive and

Table 3.12. Maximum Likelihood Estimates of Fertilizer Demand Model, 1988-92.

Variables	Arabica Parameter Estimates	Robusta Parameter Estimates
$PCAFE_{t-1}$--realized producer price	1.361 (11.46)	4.159 (14.05)
PFERTit--price per kilogram of nutrient	-1.457 (-5.328)	-4.398 (-6.516)
Variance intercept	-0.4485 (-6.532)	1.285 (7.539)
Variance parameter on farm size	0.5740 (13.04)	0.2870 (2.040)
Mean - fixed effects	1.096	-0.6688
Std dev - fixed effects	1.250	2.422
Total observations	720	770
Limit observations		442
Log likelihood value	-1067.	-868.4
Number of farms	144	154

Note: Asymptotic t-ratios are in parentheses.

significant, and rejected the null of homoskedasticity. All the price coefficients were of the correct sign and were statistically significant at conventional levels. These results affirmed farmer awareness and consideration of price differentials based on the fertilizer price per kilogram of nutrient when purchasing fertilizer.

Table 3.13 gives the estimated elasticities of observed fertilizer quantities with respect to price. The elasticities in the robusta sector were considerably more elastic than those in the arabica sector. This may be the result of a non-coffee demand for fertilizer in the arabica sector by women food crop producers in subhousehold units.

Table 3.13. Mean Elasticity Estimates of Fertilizer Demand Model, 1988-92.

Elasticity w/r/t	Arabica	Robusta
$PCAFE_{it-1}$	1.225 (0.5314)	3.168 (1.553)
PFERTit	-1.311 (0.5687)	-3.350 (1.642)

Note: Standard deviations of mean elasticity are in parentheses.

Fixed Effects Regression

Table 3.14 reports the results on the regressions of the fixed effects. In both sets of results, the influence of farm size was positive. Larger farms had higher fertilizer application *ceteris paribus*. This result may indicate a credit constraint on fertilizer purchases among smaller farms. The only other significant variable in both regressions was the measure of capital. The influence of capital on fertilizer application rates was positive as it increases the marginal productivity of fertilizer. The estimated coefficient of *WAGE* was positive contrary to expectations, but was not significant. An increase in the wage bill of a farm and the subsequent reduction in hired labor would decrease the demand for fertilizer, assuming labor and fertilizer are not substitute inputs. Similarly, family size is expected to have a positive effect on fertilizer demand. This effect, however, was only evident in the robusta sector.

The measure of scale, *QFEASIBLE*, was negative for both regressions. The implication drawn was that as a firm's potential production increases its rate of fertilizer application declined. This result was most likely due to imperfect markets and high transaction costs, which restrict the production possibilities of the larger enterprises.

Table 3.14. OLS Regression of Fixed Effects from Fertilizer Demand Model for Arabica and Robusta Coffee on Variables that Remained Fixed over the Sample Period, 1988-92.

Variable	Arabica Parameter Estimates	Robusta Parameter Estimates
INTERCEPT	0.1978	-2.331
Southwest dummy	...	-1.972 (-2.779)
FAMILY SIZE--number of persons	-0.007068 (-0.3808)	0.06689 (2.244)
CAPITAL--annual depreciation value of capital stock in 1992.	0.000011 (1.944)	0.000024 (2.541)
QFEASIBLE--mean of 1988-92	-0.000210 (-0.8121)	-.000488 (-4.262)
EDUCATION--dummy (=1, if schooling ≥ 4 years)	0.02611 (0.7432)	-0.2935 (-0.7042)
ORGANIC--dummy (=1, if farmer used organic fertilizers)	0.2306 (0.7264)	0.3609 (0.8910)
WAGE--wage bill per 1,000 trees, based on reported piece rates	0.008222 (0.7151)	1.160 (1.018)
FARM SIZE--total hectares, including fallow	0.09191 (2.756)	0.2061 (3.154)
MAIZE--dummy (=1, if maize grown in association with coffee)	0.01807 (0.2439)	...
Valid cases	124	137
Condition number	12.64	16.96
Adjusted R^2	0.077	0.189

Note: T-ratios are in parentheses.

CHAPTER 4
SECTORAL POLICY ANALYSIS

As outlined in the preceding chapters, the Cameroon coffee and cocoa sectors have been the subject of recent market reform. The most extensive reforms have occurred in the arabica sector, where the marketing regime was completely liberalized in the 1993 season. To examine impacts of these reforms on producer and marketing agent behavior, a structural monopsonistic model of the sector is compared to a competitive model. The price taking behavior assumed of marketing agents is then relaxed in a political economic model of government price regulation for the robusta sector. Before proceeding to the models, a brief description of the marketing and processing stages between the producer and the export of coffee is given.

The Structure of Coffee Marketing and Processing

Once the farmer's coffee cherries have ripened and are harvested there are several types of processing, which occur before the coffee achieves an exportable form. These include both on- and off-farm processes. Two types of processing occur on-farm. Wet processing is the prevalent mode in the arabica sector and yields the quality of coffee currently in highest demand on world markets--washed mild arabicas. In the robusta sector, dry processing is done exclusively.

Quality control in wet processing is as critical as tree culture management in achieving quality price premia. After the ripe cherries are

selectively picked, they must be immediately depulped (within 24 hours of harvest) to avoid premature fermentation.[1] Because arabica coffee does not ripen uniformly, several harvestings are usually required. Once the pulp has been removed, the beans are allowed to ferment in vats to hydrolyse the mucilage surrounding the bean. After 24-48 hours, depending on the rate of fermentation, the loosened mucilage is washed off by hand. The bean now in a parchment state is slowly dried, preferably on a raised drying rack or a concrete patio, for 2 to 3 weeks. After attaining a moisture level of 11-12 percent, the coffee is ready for sale to the cooperative. Problems in wet processing facing the small holder in Cameroon included difficulties in getting the coffee depulped within 24 hours of harvest.[2] Sufficient quantities of clean water were another constraint faced by some producers, as up to 90 liters per kilogram of clean coffee are required.

The purchase acceptance procedures of the cooperatives for washed arabica involves sampling for dried cherries and stones, which if found downgrades the coffee to the heavily discounted *triage* grade. The percentage of good beans (i.e., exhibiting a white cut, a white silverskin and a fresh odor--not smoky or over-fermented) vis-a-vis bad beans (dark coloration, over-fermented or insect damaged) is determined. The producer's crop is then weighed, and multiplied by a factor of .8 to

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[1] Selective picking was more costly than strip harvesting, the method used in the robusta sector where all of the coffee ripens together. The 1988 modal harvesting piece rates paid in the robusta and arabica sectors were 500 and 600 FCFA/50 kg sack, respectively, versus 250 and 300 FCFA/50kg in 1991.

[2] Of the arabica coffee farmers interviewed, 30 percent did not possess a coffee depulper; these farmers usually were able to borrow a depulper or pay a small fee to have their coffee depulped.

account for the parchment removal loss in processing. The calculated quantity of green coffee is then paid a weighted price based on the proportion of good versus bad beans. There are no producer premia for larger beans.[3]

Inevitably in the process of selective arabica harvesting, some beans are picked at either an under-ripened or over-ripened stage. These beans are usually dried intact without the removal of the cherry pulp. This dry processing method of producing "unwashed" coffees is less labor- and management-intensive than the wet processing method, requiring only a suitable drying area and daily turning of the coffee beans. Drying times for cherry coffee are between 3 and 4 weeks. Unwashed arabica from Cameroon was typically discounted by up to 67 FCFA for the same grade of washed arabica on world markets (Table 4.1). The producer premium paid for washed arabica ranged from 30 to 95 FCFA per kilogram from 1988 to 1991.

In the robusta sector, dry processing was used exclusively, as there is little demand for washed robustas. The transfer of coffee from producer to marketing agent in the robusta sector began with the collection at the farm gate by the huller of the farmer's dried cherries. The farmer was issued a receipt for his/her coffee, which was tagged with the farmer's identity, and transported for hulling at a fixed rendezvous with the farmer. At the hulling rendezvous, the resulting green coffee was assessed for quality and weighed in the presence of the farmer.

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[3] Langham and Ayissi (1991) detail the high selling transaction costs incurred by arabica producers in the Menoua Division of the West Province. For smaller producers, the average "tax" due simply to the procedure of rounding down weighed kilograms approached 10 percent of the total sale.

Table 4.1. Arabica Size Grades and Prices Received by UCCAO Cooperatives.

Grade	Proportion of Total Marketings 1988-92	CIF Price 1988		CIF Price 1991	
		Washed	Unwashed	Washed	Unwashed
	Percent	---------- FCFA ----------			
A	20	810	768	525	450
B	20	810	748	516	449
C	14	810	751	513	450
D	20	770	768	190	na
F	15	810	na	476	na
TRIAGE	3	563	na	190	150
BRISURE	2	587	na	na	na

Note: Prices were weighted averages for the year.
Source: Personal interviews with cooperative directors and accounting personnel of arabica marketing cooperatives in West Province, December, 1992.

Payment was typically made upon weighing, although in the late 1980s many farmers were issued scrip instead of cash. The quality of each producers' coffee was thereby known and paid accordingly. The alternative of purchasing dried cherries, common to other robusta producers such as Côte d'Ivoire, does not provide the huller with this information, but has the major advantage of permitting more efficient use of the hulling mills. In the Cameroonian system, the hulling line must be cleared of all a producer's coffee before the next lot can be run. This results in a substantial reduction of the throughput capacity and increases the costs of the marketing/processing operation.

After receiving the parchment and/or dried cherry coffee from the farmer, processing value was added by: (1) precleaning to remove debris; (2) removal of the parchment layer (and hulling if dried cherry); (3)

polishing of the bean; (4) grading by size; (5) sorting off-colored beans; and (6) assembly into exportable lots. The final sorting of the off-colored "stinker" beans can significantly increase the export value of the coffee, as even a very small portion of "stinker" beans will result in a heavy discount in the export market. Both manual sorting and mechanical sorting using bi-chromatic electronic color sorters were used. Cooperatives surveyed in late 1992, paid piece rates ranging between 3.3 and 5.7 FCFA/kg for hand sorting versus an estimated 1985 cost of electronic sorting approaching 15 FCFA/kg (de Graaff, 1986). In the 1980s several electronic sorting facilities were installed in the West and Littoral Provinces. The choice of seemingly incongruous, higher cost, capital-intensive techniques were encouraged in part by macroeconomic policy distortions, specifically, subsidized credit, a restrictive labor code, and an overvalued exchange rate which prevailed in the 1980s.

Until the recent market liberalization in 1992/93, arabica coffee was purchased by marketing cooperatives given monopsony purchase rights in the Northwest and West Provinces. Since the liberalization, anyone is allowed to purchase and market arabica coffee. The arabica cooperatives, congruent with their government sponsorship, were geographically defined by the divisional units of government in the West and Northwest. Each cooperative at the divisional level was comprised of numerous cooperative centers (primary societies in the Northwest), which were typically the point of exchange between the producer and the cooperative. There are 6 divisions in the West, each with a coffee cooperative; however, only four marketed arabica coffee to any extent. In the Northwest, there are 10 cooperative unions. The six marketing cooperatives of the West Province

are grouped under the apex organization, UCCAO, while the unions of the Northwest are associated under the NWCA.

Cameroon's oldest cooperative, founded in 1933, is CAPLAME of the Menoua Division in Dschang. There was an indication that this cooperative, the most financially viable of those belonging to UCCAO, was searching to become independent of its affiliation.

Robusta marketing agents in the West Province, in addition to the cooperatives, include private licensed hullers and licensed exporters. State-guided competition between cooperatives, licensed hullers and exporters has historically characterized the robusta sector. There are approximately 150 licensed hullers operating in Cameroon and over 60 licensed exporters of robusta (MINDIC, 1992). In the Littoral Province licensed private agents are relatively more important, while in the more remote regions of the Southwest Province, cooperatives have played a larger role. Marketing competition became less guided with the suppression of fixed collection and hulling costs in 1991. The remuneration of the huller for collecting the farmer's coffee and removing the dried hull and parchment is no longer by fiat, but is subject to negotiation between the huller and the exporter. In contrast to the complete liberalization of the arabica market, the official producer price and exporter's total margin were still set by presidential decree in 1992/93.

Data for assessing the costs of marketing in each of the two sectors were gathered from cooperatives in the West and Littoral Provinces in late 1992 and early 1993. Information from the Northwest Province was not obtained because of the political unrest and the declared state of

emergency, which followed the Presidential elections of October, 1992. The data presented below were transcribed from annual financial reports from 1988 to 1992.

Labor and energy costs were assessed on a per kilogram of export coffee basis and are presented in Table 4.2. Higher labor to output ratios, labor, and energy costs in the arabica sector may be explained by the multi-purpose nature of these cooperatives, which, in addition to marketing the producers' coffee, also distribute fertilizers, pesticides, durable inputs such as sprayers and coffee depulpers, financial credits, maintain seedling nurseries, and in the case of Menoua and Mifi divisions, were making significant public investments in projects such as rural feeder road maintenance, village electrification, rural school buildings, village water supplies and bridge construction. In contrast, the scope and scale of services provided by the robusta cooperatives were more limited.

Part of the divergence in costs between the two sectors may also be due to X-inefficiencies resulting from monopoly selling rights granted arabica cooperatives. In contrast, the robusta cooperatives were forced to operate on much tighter margins dictated by the official *bareme* and faced significant competition especially in the collection and hulling of producer's coffee from private licensed hullers. In both sectors, as the price of output has declined, the labor to output ratios, L/Y, measured as the number of permanent employees per metric ton of output has similarly declined indicating a relatively responsive labor demand with respect to product price. Finally the level of public investment in Menoua and Mifi divisions of the West Province was significant in 1988 and 1991. While it

Table 4.2. Labor and Energy Costs Per Unit of Output Among Marketing Cooperatives of the West and Littoral Provinces, 1988 to 1992.

	1988	1989	1990	1991	1992
Arabica Cooperatives					
L/Y ratio*	.099	.067	.083	.095	.043
Labor cost (FCFA/kg)	144	88	101	115	51
Energy cost (FCFA/kg)	13	8.8	12	10	6.1
Public invest.** (FCFA/kg)	20	2.6	4.2	21	3.2
FOB price (FCFA/kg)	760	812	449	439	360
Robusta Cooperatives					
L/Y* ratio	.021	.012	.014	.014	.011
Labor cost (FCFA/kg)	34	20	31	21	18
Energy cost (FCFA/kg)	6.6	5.9	7.0	6.1	6.0
FOB price (FCFA/kg)	591	494	288	258	198

*L/Y is measured as permanent employees per metric ton of output.
**Public investment applies to only CAPLAME and CAPLAMI in the Menoua and Mifi Divisions of the West Province
Source: Personal interviews with cooperative management person December, 1992 and January, 1993.

may be argued that a coffee cooperative is not likely to be the most efficient provider of such investments, nonetheless, their cumulative effect over the years has been a contributing factor to the rural infrastructure in these divisions.

The arabica marketing regime in the West Province from 1962 to 1992 provided a relatively rare exception to the Batesian urban-rural bias characterizing many African government policies (Bates, 1981). Though the coffee producers adhering to UCCAO were still subject to a high degree of implicit taxation, the public expenditures generated were, to a degree, re-invested in the rural infrastructure of the West Province (rather than benefitting the more politically influential urban population). The

diversification of the rural economy in the West Province, into areas such as commercial poultry and swine production, horticultural production for urban and export markets, rural welding enterprises, commercial eucalyptus farms, and rural commerce, owes much to the infrastructure contributed by the coffee cooperatives. If the liberalized market approaches a competitive norm, the quasi-rents captured in the past by UCCAO in the West Province will now be captured by producers and marketing agents (cooperatives). With little means of local taxation, rural infrastructure investments, dependent in the past on cooperative surpluses, are likely to decline unless alternative means of funding can be devised. This consequence of the reform should not be overlooked.

Elasticity Estimates of Producer Coffee

The investment responses to expected gross revenues were utilized to develop simulation models of output for the mean arabica and robusta producers in the survey. The impacts of increasing producer prices and the adoption of improved technology were simulated.

The formulation of expected gross revenues used in the regression analysis depends on (1) the producer's price forecasts, (2) the expected age-yield of the tree being planted, and (3) the farmer's discount rate. Changes in any of these three components will induce a change in the producer's expected revenues and investment behavior. In the production model, the change in investment behavior results in a change in the feasible production of the farm and thereby the actual output as well.

In the autoregressive model of price expectations, forecasts are revised based on the two most recently announced prices. Given the AR(1) price expectations model, the elasticity of expected gross revenues

(equation 3.5) with respect to a change in real producer price after two periods of adjustment is one. Therefore, the change induced in observed new plantings and replantings by a change in price is approximated by the elasticity estimates of expected gross revenues given in Tables 3.6 and 3.9 after two periods.

There is also a one-to-one correspondence between changes in the expected yield of a tree and the expected gross revenues of a tree. Consequently, a 10 percent increase in the age-yield profile for all age classes results in a ten percent increase in expected gross revenues. This allows an *ex ante* appraisal of the effect of varietal yield improvements on supply response.

To measure the impact of changes in expected gross revenues on observed new planting and replanting, isoelastic functions were assumed:

$$\hat{NP}_t = w_1 EGR^{\epsilon_1}$$

$$\hat{RP}_t = w_2 EGR^{\epsilon_2}$$

The multiplicative constants w_1 and w_2 were solved for at the mean values of expected gross revenues, (EGR), new plantings, replantings and the estimated mean elasticities of the observed dependent variables with respect to EGR, ϵ_1 and ϵ_2, taken from the results presented in Chapter 3. The question of which mean value of EGR to use for the base run arises because of the varying periods of estimation (23, 8 and 5 years) for the three equations of concern--new planting, replanting, and short-run supply. The decision was made to use weighted average values calculated in terms of 1989 real prices; these prices were 578 and 471 FCFA for arabica and robusta, respectively. It should be noted that these values are higher than the November 1993 price projections of the World Bank for

the year 2005, which are projected to be somewhere in the neighborhood of 450 FCFA and 337 in 1989 constant FCFA for arabica and robusta, respectively. The levels of new planting and replantings predicted by these equations were then used to update the mean producer's feasible production.

The average empirical vintage distribution of trees in 1992 was updated to provide future predictions of feasible output. The measure of feasible production developed in the study was affected by issues encountered in deriving the empirical age-yield profiles. In particular an accounting for unobserved replanting rates was not made. The average age-yield profiles were calculated from producer production records with no information on replantings. Therefore, the older vintages included an unknown proportion of variously aged reset trees. For example, a coffee plantation of 1000 trees created in 1960 and 32 years of age in 1992 might have contained 700 trees of actual 32 years age, the rest being resets of some age less than 32 years. But as replanting information was not available, the production of the plantation was considered to be exclusively from trees aged 32 years. The resets would normally tend to bias upwards the mean estimate of the productivity of a tree aged 32 years. The calculated age-yield profile, $Y(A)$, thus reflects some "average" level of replanting. Because of this, deviations from mean replantings[4] were considered to be a net addition to the tree stock. It

[4]The mean level of replanting was assumed to be that level prevailing from 1984 to 1988 for robusta coffee, which was the period covered by production records. For arabica, the mean level observed was from 1984 to 1992, which was similarly the period for which the majority of production records pertained.

should be noted that the net addition to the tree stock (new plantings plus net replantings) becomes negative for low producer price.

The forecasted vintage distribution $NT(A)$ of the mean farm at time $t+f$ was defined as

$$\begin{aligned} NT(A=a)_{t+f} &= N\hat{P}_{t+f-a} + NE\hat{T}RP_{t+f-a} \qquad for\ 1 \le a < f \\ NT(A=a)_{t+f} &= \overline{NT}(A=a-f)_{t} \qquad for\ f \le a \end{aligned} \tag{4.1}$$

NP_{t+f-a} and $NETRP_{t+f-a}$ were the predicted levels of new planting and net replanting at time $t+f-a$ given expected gross revenues at $t+f-a$. Vintages older than f, were taken from the average empirical distribution, NT. Under the assumption of no technological change, the predicted level of feasible output, $QFEASIBLE_{t+f}$, was the inner product of the vector $NT(A)$ and the age-yield profile $Y(A)$.

The model can also accommodate new varieties. Assume yields increase uniformly over all age classes by E percent at time $t+1$. Assume also that the mean producer adopts completely the new variety in his/her plantings. $QFEASIBLE_{u}$ is then the sum of the inner products:

$$\begin{aligned} NT(A_{OLD}=a)_{t+f} &= 0 \qquad\qquad 1 \le a < f \\ NT(A_{OLD}=a)_{t+f} &= \overline{NT}(A_{OLD}=a-f) \qquad f \le a \end{aligned}$$

$$\begin{aligned} NT(A_{NEW}=a)_{t+f} &= N\hat{P}_{t+f-a} + NE\hat{T}RP_{t+f-a} \\ &\quad + \frac{E*R\hat{P}_{t+f-a}}{1+E} \qquad 1 \le a < f \quad for\ NE\hat{T}RP \ge 0 \\ NT(A_{NEW}=a)_{t+f} &= N\hat{P}_{t+f-a} + \frac{NE\hat{T}RP_{t+f-a}}{1+E} \\ &\quad + \frac{E*R\hat{P}_{t+f-a}}{1+E} \qquad 1 \le a < f \quad for\ NE\hat{T}RP < 0 \\ NT(A_{NEW}=a) &= 0 \qquad\qquad f \le a \end{aligned} \tag{4.2}$$

$$QFEASIBLE_{t+f} = Y(A)'NT(A_{OLD})_{t+f} + (1+E)*Y(A)'NT(A_{NEW})_{t+f}$$

$NT(A_{OLD})$ and $NT(A_{NEW})$ are the age distributions of the old and new technology. In addition to the impact on *QFEASIBLE* from the net replantings, the total level of replantings would have a net impact of *E*Y(A)'RP* on feasible production where *RP* is total number of trees replanted. In the simulations undertaken, it was assumed that the varietal innovation was such that there was a uniform 10 percent increase over all age classes. This was done mainly for the sake of simplicity, however, if the innovation was such that there was a non-uniform shift in the production technology, this could be easily handled if the empirical age-yield profile was known.

It might seem logical to assume that replanted trees in year t replaced the oldest tree stock at the tail of the distribution. This approach would, however, underestimate the short-and medium-term response by over-estimating the negative effect from removed trees, which according to the age-yield profiles (figures 3.1 and 3.2) was still large. Empirically it was clearly evident through the interviews that most producers replaced either dead or diseased trees of low productivity.

To translate feasible production into predicted actual production, Q_{t+f}, the parameter values from the short-run supply function were utilized assuming the following isoelastic form,

$$\hat{Q}_{t+f} = w_3 P_{t+f}^{\phi_3} QFEASIBLE_{t+f}^{\phi_4} \qquad (4.3)$$

with w_3 solved for at the mean values of Q, P, and *QFEASIBLE* over the 1988-92 period.

Using equation 4.3, the output response of the mean robusta and arabica producer were projected 20 years into the future. The prices used

for the base projections, 471 and 578 FCFA, reflect the average price received over the estimation period for robusta and arabica respectively. These prices were then increased by 10 percent to reflect a 10 percent increase in expected gross revenues. The output responses of the mean producer from a similar-sized increase in expected revenue resulting instead from a 10 percent increase in yields, at the base prices were also simulated. The change in producer surplus for the two prices was calculated.[5]

The results of the simulations are found in Tables 4.3 and 4.4. In all six of the output simulations presented, producer output was increasing at the given price and yield assumptions. In the arabica sector, the net output increase after 20 years at the baseline price was 24.8 percent; while the robusta sector exhibited an increase of 23.4 percent. The yield increase of 10 percent resulted in an output increase of 24.8 and 45.5 percent in the arabica and robusta sectors, respectively, after twenty years. Because of the much larger size of the average robusta farm, the change in producer surplus was also much larger. This is an important indicator of the economic motivation with regards to technology adoption and the supply of political influence.

In addition to the simulations reported in Tables 4.3 and 4.4, a grid search over various prices was conducted to determine the price at which annual production remain relatively constant over time. In the

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[5]Calculated in the robusta case, for example, as:

$$\Delta PS = \int_{471}^{521} w_0 \, P^{\epsilon_s} \, dp$$

where w_0 was solved for at the midpoints of the changes in estimated output and price.

Table 4.3. Output and Producer Surplus Forecasts for Real Price Equal to 471, 521 FCFA, and a 10 Percent Increase in Yields of New Plantings and Replantings for the Average Robusta Producer.

Year	P=471	P=521	P=471 and 10% Yield Increase	Change in Producer Surplus
	----kgs of hulled coffee----			1989 FCFA
1995	2514	2603	2846	124618
1996	2506	2598	2508	124347
1997	2524	2614	2524	125103
1998	2551	2661	2588	127225
1999	2596	2727	2658	130238
2000	2679	2878	2719	132421
2001	2649	2825	2781	134572
2002	2679	2878	2846	136938
2003	2649	2916	2658	138596
2004	2731	2878	2967	141245
2005	2766	3032	3035	143805
2006	2806	3095	3109	146626
2007	2863	3175	3199	150277
2008	2806	3234	3269	152925
2009	2949	3304	3348	156108
2010	2982	3359	3414	158577
2011	3007	3403	3469	160549
2012	3044	3461	3537	163151
2013	3067	3504	3591	165061
2014	3103	3561	3657	167612

arabica sector, the output for the mean producer utilizing the traditional variety was stable at a level of 482 kilograms and a price of 320 FCFA/kg. Prices above 320 FCFA resulted in positive growth in production, while lower prices resulted in declining production over time for the mean

Table 4.4. Output and Producer Surplus Forecasts for Real Price Equal to 578, 639 FCFA, and a 10 Percent Increase in Yields for the Average Arabica Producer.

Year	P=578	P=639	P=578 and 10% Yield Increase	Change in Producer Surplus
	-----kgs of washed coffee-----			FCFA
1998	621	676	621	38593
1998	618	676	618	38428
1998	685	653	676	38868
1998	631	660	634	39259
1999	637	668	643	39701
2003	643	676	653	40142
2004	653	688	653	40595
2002	664	688	686	41116
2003	664	704	686	41618
2004	673	717	700	42302
2005	685	732	748	43085
2005	685	748	734	43960
2007	709	768	768	44752
2005	700	704	768	45542
2009	731	790	783	46270
2010	742	804	799	47032
2011	749	815	811	47589
2012	758	826	823	48156
2013	765	835	834	48689
2014	775	847	847	49350

producer. When a uniform increase in yield of 10 percent was assumed, the same mean level of annual production was forthcoming for a price of 290 FCFA/kg. In the robusta sector, production was stable at a level of 2,282

kilograms and a price of 365 FCFA/kg for the traditional variety versus 325 FCFA for an assumed yield increase of 10 percent.

The difference in the price required to stabilize production for the traditional versus higher yielding varieties provides an indication of the shadow value of the varietal innovation for the producer. The higher value in the robusta sector (40 FCFA/kg) versus the arabica sector (30 FCFA/kg) was due to the greater responsiveness of new plantings to expected gross revenues in the robusta sector.

Given the dynamics of supply response, inefficiencies in the pricing regime result in growing deadweight social losses and increasing losses in producer surplus over time. To illustrate the impact on deadweight social loss, a 10 percent export tax was implemented on the mean robusta producer at a price of 521 FCFA. An annual deadweight loss of 2,209 FCFA was incurred in the first year, a 6,058 loss by the tenth year, and an 11,455 loss in the twentieth year. Given more than 30 years of producer prices suppressed 40 to 60 percent below border prices, the accumulated social losses have been substantial.

The corresponding price and yield elasticity estimates are found in Table 4.5. The output of arabica coffee in the short-run is more price responsive than robusta coffee reflecting a more diversified rural economy and greater off-farm employment. However, after 5 years of adjustment, the robusta sector becomes more responsive to price changes as a result of a greater elasticity of new plantings and less of a yield dropoff in its empirical age-yield profile (compare figures 3.1 and 3.2).

The yield innovation elasticity was significantly higher in the robusta sector due to a higher elasticity of new plantings (Table 4.5).

Table 4.5. Estimated Price and Yield Elasticities for Mean Arabica and Robusta Producers.

	Robusta		Arabica	
Period	Price	Yield	Price	Yield
immediate	0.3505	0.0000	0.4288	0.0000
5 years	0.4924	0.2362	0.4758	0.0923
10 years	0.8557	0.8271	0.6291	0.3907
15 years	1.1355	1.2697	0.7869	0.6912
20 years	1.3759	1.6417	0.8897	0.8832

The higher new planting elasticity combined with existing on-the-shelf "elite" clonal varieties, shown to out-perform by a factor of 5 to 10 current existing on-farm varieties, indicate that a more rapid output response would result from yield innovations in the robusta sector. In the arabica sector, where the land constraint reduces the elasticity of new plantings, and yield innovations have been hampered by relatively greater pest problems, the output response from higher yielding varieties will take longer to materialize.

The African Development Bank, after settling arrears with the government of Cameroon, has indicated intentions to provide investment lending for regenerating the Cameroonian coffee sector through the dissemination of improved coffee varieties. The role of the public and private sector in this effort needs to be addressed. The agronomic skills required to operate a nursery utilizing clonal techniques of plant propagation are well within the set of skills of agronomic graduates from the national agricultural university. In the setting of a relatively well developed communications infrastructure (i.e., Littoral and West Province) the emphasis of the state should be on encouraging and supporting

privately owned nursery enterprises for reasons of economic efficiency. This may require extension outreach in the area of business management and access to the improved clonal materials of the public research institutes and/or the *Institut de la Recherche du Café et Cacao*, (IRCC), the French coffee and cocoa research institute based in Montpellier, France. In the more remote areas of the Southwest and East Provinces, a greater reliance on the public sector may be needed for small farmers to benefit. In these areas, assistance in distribution of clonal materials sourced from private nurseries is recommended.

An Analytical Model of the Coffee Sector

To analyze the economic impact of changing policy instruments on the coffee sector an adaptation of the two-input, single-output model originally used by Hicks (1932) in the analysis of labor issues and first applied to the analysis of farm policy by Floyd (1965) was developed. The model was modified to examine monopsonistic profit maximization by the ONCPB prior to the reforms, which began in 1989.

The linear homogeneous technology is described by

$$x = f(a, b) \tag{4.4}$$

where x is the quantity of green coffee produced for export, a is the quantity of producer coffee utilized in the production process, and b is the quantity of marketing/processing input (a capital-labor aggregate) used in conjunction with a to produce exportable coffee. The assumption is that the ONCPB seeks to maximize profits (government net revenues) by the setting of P_a and P_b. Its objective function is

$$\pi = P_x f(a, b) - g(a)\, a - h(b)\, b \tag{4.5}$$

where $P_a = g(a)$ and $P_b = h(b)$, are the inverse supply functions for parchment/dried cherry coffee and marketing/processing services, respectively. The first-order conditions for a profit maximum are:

$$f_a P_x = P_a + g_a a \tag{4.6}$$

$$f_b P_x = P_b + h_b b \tag{4.7}$$

P_x is the world price for Cameroon coffee, and g_a and h_b the derivatives of the inverse supply functions. The right-hand sides are simplified as:

$$\begin{aligned} f_a P_x &= m_a P_a \\ m_a &= 1 + \frac{1}{e_a} \\ e_a &= \frac{\partial a}{\partial P_a} \frac{P_a}{a} \end{aligned} \tag{4.6'}$$

$$f_b P_x = m_b P_b \tag{4.7'}$$

where for the factor b, m_b is defined analogously to m_a. The final two equations in the model are the input supply functions:

$$a = j(P_a) \tag{4.8}$$

$$b = l(P_b) \tag{4.9}$$

Equations 4.1,4.3',4.4',4.5 and 4.6 comprise the basic model. There is no demand function specified as Cameroonian production is "small" relative to the world market, so that P_x is exogenously determined by world markets.[6]

[6] In arabica production Cameroon accounts for less than 1 percent of the world total; for robusta the share varies between 2 and 4 percent.

To examine changes in the model, totally differentiate:

$$dX = f_a da + f_b db \tag{4.4"}$$

$$(f_{aa} da + f_{ab} db) P_X + f_a dP_X = m_a dP_a \tag{4.6"}$$

$$(f_{ba} da + f_{bb} db) P_X + f_b dP_X = m_b dP_b \tag{4.7"}$$

$$da = g_a dP_a \tag{4.8"}$$

$$db = h_b dP_b \tag{4.9"}$$

and convert to elasticity form through use of the following:

$$EP_X = \frac{dP_X}{P_X}$$

$$g_a = \frac{\partial a}{\partial P_a}$$

$$e_a = \frac{\partial a P_a}{\partial P_a a} \qquad g_a = e_a \frac{a}{P_a}$$

$$f_{aa} = -\frac{b f_a f_b}{a X \sigma} \qquad f_{ab} = f_{ba} = \frac{f_a f_b}{\sigma X}$$

$$f_a = \frac{P_a}{P_X} \qquad f_b = \frac{P_b}{P_X}$$

where σ is the Allen elasticity of substitution in production between a and b (given the assumption that $f(a,b)$ is linear homogeneous).

Following algebraic manipulation, the matrix equation is written

$$\begin{bmatrix} 1 & 0 & 0 & -\frac{P_a a}{P_x x} & -\frac{P_b b}{P_x x} \\ 0 & m_a & 0 & \frac{P_b b}{P_x x\sigma} & -\frac{P_b b}{P_x x\sigma} \\ 0 & 0 & m_b & -\frac{P_a a}{P_x x\sigma} & \frac{P_a a}{P_x x\sigma} \\ 0 & -e_a & 0 & 1 & 0 \\ 0 & 0 & -e_b & 0 & 1 \end{bmatrix} * \begin{bmatrix} Ex \\ EP_a \\ EP_b \\ Ea \\ Eb \end{bmatrix} = \begin{bmatrix} 0 \\ EP_x \\ EP_x \\ 0 \\ 0 \end{bmatrix} \qquad (4.10)$$

Of particular interest, given the Cameroonian context of market liberalization and the recent upturn in world coffee prices due to the recent supply shocks in Latin America, are the effects of a change in the exogenous world coffee price on export quantity, producer price and the exporter's marketing margin.

The impact can be measured by dividing the matrix equation by EP_x.

$$\begin{bmatrix} 1 & 0 & 0 & -\frac{P_a a}{P_x x} & -\frac{P_b b}{P_x x} \\ 0 & m_a & 0 & \frac{P_b b}{P_x x\sigma} & -\frac{P_b b}{P_x x\sigma} \\ 0 & 0 & m_b & -\frac{P_a a}{P_x x\sigma} & \frac{P_a a}{P_x x\sigma} \\ 0 & -e_a & 0 & 1 & 0 \\ 0 & 0 & -e_b & 0 & 1 \end{bmatrix} * \begin{bmatrix} \frac{Ex}{EP_x} \\ \frac{EP_a}{EP_x} \\ \frac{EP_b}{EP_x} \\ \frac{Ea}{EP_x} \\ \frac{Eb}{EP_x} \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \\ 1 \\ 0 \\ 0 \end{bmatrix} \qquad (4.11)$$

Solving for the various elasticities (let $k_a = Ap_a/xP_x$ and $k_b = Bp_b/Xp_x$):

$$\begin{bmatrix} \frac{EX}{EP_x} \\ \frac{EP_a}{EP_x} \\ \frac{EP_b}{EP_x} \end{bmatrix} = \begin{bmatrix} \frac{k_a e_a\left(\frac{k_a e_b}{\sigma} + m_b\right) + k_b e_b\left(\frac{k_b e_a}{\sigma} + m_a\right) + 2\left(\frac{k_a k_b e_a e_b}{\sigma}\right)}{D} \\ \frac{\frac{k_b e_b}{\sigma} + \frac{k_a e_b}{\sigma} + m_b}{D} \\ \frac{\frac{k_a e_a}{\sigma} + \frac{k_b e_a}{\sigma} + m_a}{D} \end{bmatrix} \qquad (4.12)$$

where: $D = \frac{m_a k_a e_b}{\sigma} + \frac{m_b k_b e_a}{\sigma} + m_a m_b$

The solutions for the factor market elasticities with regards to border prices are given by $e_a^* EP_a/EP_x$, and $e_b^* EP_b/EP_x$ for producers' green coffee and for the marketing input respectively. The relative magnitudes of the elasticities of producer price, EP_a/EP_x, and marketing services cost, EP_b/EP_x, are shown to depend on the factor supply elasticities. If the supply of producer coffee is relatively more inelastic than the supply of marketing services, then a revenue maximizing government would increase the producer price, P_a, relatively more than marketing services costs, P_b, for a given increase in the world price.

These results show the effects of a change in green coffee price, under the assumption that the prices paid to producers and marketing agents are the monopsonistic profit-maximizing prices. The above model can easily be modified to examine the case of a competitive market for export coffee, i.e., with many buyers of *a* and *b*, by allowing m_a, m_b to equal one. To evaluate quantitative changes in the equilibrium requires estimates of the parameters of the model--e_a, e_b, and σ as well as information on P_a, P_b, *a*, and *b*.

Monopsonistic and Competitive Model Simulations

Incorporating the producer elasticity results, the monopsonistic sectoral model developed above, was compared to the competitive model to examine the implications of recent efforts to liberalize the coffee markets. While liberalization is not likely to result in a competitive market structure in the short-run because of the dominant position of the cooperative marketing sector prior to liberalization, the competitive case, nonetheless, provides a target towards which the coffee sector may be headed.

The model was solved for robusta and arabica, respectively, using averages of f.o.b. prices (992 and 993 FCFA), producer prices (415 and 442 FCFA), output (91,174 and 20,172 MT) prevailing from 1982 to 1987 and the simulated producer supply elasticities for the immediate, five and ten year periods. The marketing cost assumed was taken from the *bareme* for robusta coffee for this period and was equal to 191 FCFA. Two parameters in the model were not identified: the elasticity of substitution in production of f.o.b. coffee between a farmer's unprocessed coffee and the aggregate marketing input; and the elasticity of supply of the marketing input with respect to changes in its price. The elasticity of substitution is certainly low, as a given quantity of export coffee production requires a fixed proportion of unhulled producer coffee in conjunction with a nearly fixed proportion of marketing input. The estimations were conducted assuming values for σ and the marketing elasticity equal to .1 and 1.35 respectively.[7]

[7] The elasticity of marketing input was grossly estimated by using data on recent compressions in the marketing margins and export quantities from 1988 to 1992. Data for estimating an industry-level supply function

The simulations are presented in Table 4.6. The simulated elasticity of producer price to world price was estimated to be relatively inelastic under the single buyer and of similar magnitude in both sectors. The estimates are in general agreement with the results of Gockowski and Emerson (1994) who found a similar inelastic response in a regression analysis of the level of official producer prices.[8]

Table 4.6. Simulated F.O.B. Price Elasticities of Export Coffee, Producer Price, and Unit Marketing Cost for Immediate-, 5 Year- and 10 Year-run Producer Supply Elasticities.

	Ex/EP_x		EP_a/EP_x		EP_b/EP_x	
Assumed Supply Parameter e_a	Mono-psonist pricing	Competitive pricing	Mono-psonist pricing	Competitive pricing	Mono-psonist pricing	Competitive pricing
Robusta sector						
.3505	0.080	0.281	0.357	1.300	0.107	0.349
.5326	0.151	0.403	0.454	1.232	0.191	0.495
.9783	0.336	0.655	0.559	1.094	0.410	0.796
Arabica sector						
.4288	0.112	0.346	0.398	1.255	0.139	0.408
.4683	0.133	0.374	0.434	1.241	0.164	0.440
.6024	0.196	0.463	0.500	1.197	0.236	0.542

The shift in marketing regimes from a single buyer to a competitive system results in much greater factor price responsiveness. There are

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was not available. The procedure used estimates a quasi-supply function rather than the true supply function.

[8] World coffee price was among a series of variables regressed on the level of official producer prices in the robusta and arabica sectors. Its effect was significant with an estimated elasticity of .13 and .15 in the robusta and arabica sectors for 1963 to 1985.

several implications for both producers and market agents. Price and income instability engendered by a change in the pricing regime are likely to favor the larger, better endowed producers and market agents. The effect on the risk-averse producer's supply response will depend locally on the ability of mainly informal credit and saving societies to provide lending insurance against this volatility.[9] In areas of the West and the Northwest Provinces, informal savings groups known as *tontines* or *njangis* have proven to be adaptable institutions serving a wide variety of personal financial needs in the face of relatively unstable incomes.

The change in pricing regimes increases the export elasticity of output as well. Both the size and distribution of surpluses change. This raises the question of the effect on overall growth of such a redistribution. To the extent, that agents' surpluses are re-invested in local rural economies, the impact should be an increase in regional growth. On the production side, the preponderance of Bamiléké producers, well known for their entrepreneurial endeavors, is likely to result in a large multiplier effect. Ownership in the marketing sector is, to a much larger degree, in the hands of expatriates, who at least anecdotally exhibit a lower propensity to invest and consume domestically than their indigenous counterparts.

Producer Price Elasticity and the Monopsonist's First Order Condition

It is argued below, that the ability of the ONCPB to act as a revenue maximizing monopsonist is countervailed by the influence wielded

[9] Urdry (1994) has recently shown that quantitatively important insurance payments are embedded in loan repayments in an empirical investigation of the role of rural credit markets in northern Nigeria.

by the exporters. However, its behavior towards the producers is much more likely to approach that of a revenue maximizing norm, due to free-ridership constraints to collective action among producers in the rural milieu. The ONCPB's first-order condition for the level of producer price is

$$P_{producer} = P_{fob} * \frac{e_s}{(1 + e_s)} \qquad (4.13)$$

where e_s is the industry elasticity of producer supply with respect to producer price.

Given f.o.b. and producer prices and the assumptions underlying equation 4.13, the producer elasticities, e_s were revealed. From 1963 to 1977, in both sectors the revealed elasticities were considerably higher than for the 1967-87 period (Table 4.7). Under the assumption of monopsonistic government pricing, this divergence could indicate either: (1) an increasingly inelastic supply response overtime on the part of producers (assuming no change in the time horizon of the optimizing monopsonist); or (2) a change in the discount rate of government (assuming no change in the elasticity parameters of small holders); or (3) some combination of (1) and (2). The exigencies of the phenomenal growth in the public sector, which began in 1977, may lend support to a higher discount rate and shorter planning horizon. However, as argued heuristically above, one of the reasons for the lower elasticity of the arabica sector is its relative maturity and greater costs of creating new plantations. Given decreasing producer supply elasticities over time, the proportion of the revenue maximizing producer price to world price would similarly be declining. Finally it is noted that the range of elasticities

Table 4.7 Official Producer Prices, World Prices and Producer Supply Elasticity Implied by a Revenue-Maximizing Marketing Board.

	Robusta			Arabica		
Period	Mean FOB Price	Mean Producer Price	Implied Elasticity	Mean FOB Price	Mean Producer Price	Implied Elasticity
1963-76	198.9	119.2	1.497	264.8	152.5	1.359
1977-87	875.2	339.5	0.634	916.4	362.7	0.655

Source: Price data taken from Losch, Fusillier and Dupraz, *"Strategies des Producteurs en Zone Cafeiere et Cacaoyere du Cameroun"*, CIRAD, 1990.

for the mean producer in the survey presented in Table 4.5 encompass the implied elasticities in Table 4.7 with the exception of the arabica sector in the first period.

The assumption of monopsonistic behavior in the setting of the exporter's margin is a stronger assumption for several reasons. The first is that, given the structure of the marketing sector, agents are more likely to organize and exert a political influence on the determination of the official marketing costs. The second reason is that the ONCPB, while supplying bureaucratic advice to the Office of the Presidency on the level of the *bareme*, was itself a supplier of marketing services in the Northwest and Southwest Provinces. Given bureaucratic rent-seeking, ONCPB agents would have had preferences for administered marketing costs above their government revenue maximizing levels. These and other political economic determinants of government price regulation are now examined in the larger robusta sub-sectors.

Structure, Political Influence and Regulation in the Robusta Sector

Three overlapping groups of agents exist in the robusta coffee sector with varying interests in the *bareme*--the set of government fixed prices issued annually. First in number are the peasant producers totaling between 150,000 and 170,000 by various estimates. The second group, numbering approximately 150, consists of licensed buying firms and government-sponsored marketing cooperatives who collect and dehull the dried coffee cherries. The third group consists of the 60 licensed exporters, of whom 17 were active in 1992, having a four-firm industry concentration ratio of 63.5 percent (MINDIC, 1992; USAID, 1992). This group carries out the marketing functions of sorting, grading, bagging, negotiating the sale and transporting the coffee from the huller ultimately to the port of entry in Europe. The main overlap among these groups occurs between the exporters and the hullers, where the majority of the exporters also carry out the marketing functions of the licensed buying firms as well. There is considerably less overlap between growers and hullers and growers and exporters.

In addition to these groups, (and outside this analysis), is the *Compagnie Foresterie Sanga-Oubangui* (CFSO), a French-owned subsidiary with approximately 3,000 hectares of robusta coffee in the East Province of Cameroon. In a marketing arrangement established prior to independence they have been able to retain the privilege of exporting their production directly, and have therefore captured rents denied other market participants.

Table 4.6 presents the official *bareme* from 1987 to 1992 and its breakdown among the various market participants (lines 13-15) and

government (sum of lines 6, 7 and 12). Line 12 indicates the tax (subsidy), which is the difference between the bareme CIF value (line 10) and the actual CIF price received by the exporter (line 11). Normally, the greatest portion of government revenues from the robusta coffee sector were raised from this differential. To illustrate, UCCAO, licensed to export robusta coffee, sold its coffee in 1987 to overseas buyers at an average CIF price of 1,065 FCFA per kilogram, thus exceeding the sum of the *bareme* (line 10) by 328 FCFA per kilogram, which UCCAO paid to the National Produce Marketing Board (ONCPB). Assuming a similar result for the 85,000 tons of coffee exported that year implies a total collection of over 27 billion francs (approximately $100 million) by the ONCPB, in addition to government revenues indicated by lines 6 and 7.

In 1988 and 1989, subsidies totaling approximately 30 billion francs were owed by the ONCPB as world coffee prices plummeted (line 12) forcing the ONCPB into arrears with numerous market agents and coffee producers in 1989. Given the comparably sized positive result in 1987 and the purported stabilization function of the ONCPB, the issue of arrears is at first puzzling. In fact, revenues generated in the mid 1980s when world prices were high, had been appropriated into the national accounts. Government expenditures and the size of government grew rapidly through the mid 1980s, stimulated by oil royalties from discoveries in the late 1970s. When oil prices fell in 1986, the resulting budget deficits eroded the surpluses of the ONCPB and began to force economic reforms.

In 1989, following the negative result of the previous year, cuts in the *bareme* were made, mainly in the marketing costs of exporters and coffee hullers (see lines 13-15). While the official price to producers

Table 4.6. Evolution of the *Bareme* for Robusta Coffee 1986/87 to 1991/92.

	1987	1988	1989	1990	1991	1992
	----------FCFA/KG----------					
1. Producer price	440	440	440	175	155	155
1a. Quality premium*	30	30	15	0	0	0
2. Collection cost	19.4	19.4	16.0	12.3	15.0	n.a.
3. Hulling cost	30.5	30.5	23.7	21.0	20.6	n.a.
4. Sort, grade, transport	33.2	33.2	25.0	25.0	39.2	n.a.
5. Finance capital	39.2	39.2	25.9	28.3	18.9	n.a.
6. Port costs, minor taxes,	10.6	10.6	10.6	10.8	16.7	n.a.
7. Export tax	65.6	65.6	65.6	0	0	n.a.
8. Profit	17.3	17.3	14.0	10.3	13.6	n.a.
9. Ins & freight	51.3	51.3	41.9	33.2	34.0	n.a.
10. CIF value	737.0	737.0	661.1	315.9	333.0	308.00
11. CIF received UCCAO	1,065	591	494	288	258	n.a.
12. Tax (Subsidy)	328.0	-146.0	-167.1	-27.9	-75.0	n.a.
13. Total Producers	470.00	470.00	455.00	175.00	155.00	155.00
14. Marketing Cost for Hullers	49.90	49.90	39.70	33.30	35.60	n.a.
15. Marketing Cost for Exporters	141.00	141.00	106.80	96.80	105.70	n.a.

Sources: ONCPB *Service Embarquements Cafés, 1987/88 through 1989/90; MINDIC,* Etude des Charges Incompressibles Filierers Cafe Robusta Campagne 1991/92; UCCAO from statistics received in interview, January, 1993.

* Premia were paid for *superieure* and *courante* grades only.

was relatively unchanged, in actuality, the realized price was much lower because of significant nonpayment as discussed in chapter three. In 1990, the government, through recourse to Stabex funds from the European Community, partially settled accounts with coffee farmers and marketing agents and carried out the marketing campaign after significantly cutting the official producer price. Under pressure from international donor agencies (mainly the World Bank and the French *Caisse français de développement*), the government dismantled the ONCPB, whose work force had grown to 2,800, and replaced it with the *Office Nationale du Café Cacao* (ONCC). The much smaller ONCC was mandated only with quality control and regulating the remnants of the *bareme*.

The most important institutional group for the coffee sector in terms of policy decision-making is the Presidency of the Republic. The *bareme* through 1990 was issued annually by Presidential decree after recommendations by the Ministry of Development and Commerce and the ONCPB. Until 1991, the *bareme* regulated the prices to be paid to each of the various agents in the coffee and cocoa sectors. Following the dismantling of the ONCPB in 1991, it is negotiated with the *Groupément des Exportateurs* (GEX), an association of exporters formed in 1990, and only fixes the producer price and the overall marketing margin of the exporter. The internal marketing costs of collection and dehulling since 1991 have been determined competitively by the exporter and the licensed buying firm in a liberalized market. Even though the explicit cost is no longer established, there is an allowance made for this cost by the state to the exporter. In essence the *bareme* remains in effect only for exporters and producers. Its annual determination generates intense interest among

these interest groups, who seek an assignment of maximum value to the tasks in their domain.

Various explanations have been offered for the rural bias expressed in terms of high commodity taxation through administered prices and overvalued exchange rates in developing countries. Lipton (1977), Bates (1981), and others (Sandbrook, 1986; Bienen, 1987; Ntangsi, 1987)[10], explain these policy biases as the politically rational outcome of the interplay between politicians seeking to remain in power and urban coalitions offering support and legitimization in exchange for favorable political considerations. The argument is founded on the high cost of collective action in the rural area, which results in the political marginalisation of the rural populace and the favoring of urban-industrial over rural interest groups.

The achievement of political influence by collective lobbying action has been examined by Olson (1965) and Stigler (1971). Successful lobbying action requires the voluntary production of a public good. It is more likely, *ceteris paribus*, the fewer the numbers in the interest group, the more asymmetric their interests, the greater the market concentration, and the more homogeneous the group. Brock and Magee have formalized these relationships in their power function model of lobbying (see Magee, *et al.*, ch. 6, 1989). Their model is applied to the robusta coffee sector and the political determination of the *bareme*.

Modelling the producer and the exporter interest groups as engaged in a noncooperative game to provide lobby pressure, total lobbying expenditures are determined endogenously and reach a noncooperative

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[10] For a critical view see Merrilee Grindle, (1991).

equilibrium defined as the point where no individual in any interest group can improve her/his subjective net gain G_i by altering her/his contribution to the group.

Definition 1. x_e and y_e is a noncooperative equilibrium if for each i, j

$$\begin{aligned} G_i(X_i^e+x_i^e, Y^e, x_i^e, S_i(t)) &\geq G_i(X_i^e+x_i, Y^e, x_i, S_i(t)) \\ -L_j(X^e, Y_j^e+y_j^e, y_j^e, C_j(t)) &\geq -L_j(X^e, Y_j^e+y_j, y_j, C_j(t)) \end{aligned} \tag{4.14}$$

where:

Gi = subjective expected net gain by exporter i (=1,...,n), and is increasing in total lobbying expenditures, $X_i^e + x_i^e$; non-increasing in the lobby contribution of the opposing interest group, Y^e, increasing in the surplus stake, S_i, and initially increasing for small values of x_i and then decreasing,

Lj = subjective expected net loss by producer j (=1,...,m),

$X(Y)$ = total lobbying resources raised by n exporters (m producers),

$x_i(y_j)$ = lobbying contribution of ith exporter (jth producer), and

$S(t),(C(t))$ = exporter (producer) surplus gains from *bareme* level t.

If for each outcome t of the *bareme* there is a unique equilibrium, then the functions $X^e(t)$ *and* $Y^e(t)$ are the "lobbying functions" of the exporters and the producers, respectively. The way in which the political process chooses the optimal level of t is not considered.[11]

Assume that there are n equal sized firms and that opposing lobby contributions are constant. Exporters are assumed to maximize their

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[11] See Brock and Magee (1974, 1975, 1978) and Peltzman (1976). Brock and Magee develop a model of rational political choice among "powerless" politicians who choose the optimal tariff equating the positive marginal effect of campaign contributions from the favored lobby with the negative redistributive effect. Because of an elastic supply of politicians and low costs of entry, failure to do so results in campaign defeat.

subjective gains defined as,

$$Max\ G_i = S_i[a\log(\sum x_i) + b\log x_i] - x_i \tag{4.15}$$

Where a measures the individual's perceived effectiveness of the total lobbying effort X; and b measures the Olson's concept of gain from the noticeability of participating in amount x_i among their peers. Restrictions on a and b include a, $b \geq 0$, $a+b \leq 1$. Solving for the optimal contribution of firm i,

$$x_i = S_i\left(\frac{a}{n} + b\right) \tag{4.16}$$

and noting that $X=nx_i$ and further noting that the Herfindahl index of surplus stakes, H, from the redistribution t , i.e.,

$$H = H(S_1, \ldots, S_n) = \sum_i [S_i/(\sum_k S_k)]^2 \tag{4.17}$$

is simply $H = 1/n$ for an industry composed of n equal sized firms, yields the industry equilibrium lobbying function X,

$$X = nS_i(aH+b) \tag{4.18}$$

If we assume parameter values of $a=1$ and $b=0$, the power function of the exporter becomes

$$P = H(\sum S_i) \tag{4.18}$$

$\Sigma_i S_i$ is the total surplus stake of the interest group determined by the setting of the *bareme*. P is homogeneous of degree one in lobby surplus stakes S_i, and is increasing in the level of concentration.

The power function can be used to predict the amount of resources that a lobby would supply for a given change in the *bareme*. The power functions for producers and exporters were calculated by assuming a

constant elasticity producer supply function, i.e., $Q_t = 12,880P_t^{0.3505}$, and the constant elasticity quasi-supply function for dehulled coffee and exportable coffee CIF Douala used in the model simulations described above, i.e., $Qh_t = 73.40MCh_t^{1.395}$.[12] The calculations and the total change in surplus for producers and exporters are given in Table 4.8.

Becker (1983) emphasizes the importance of the relative, rather than the absolute, amount of free-ridership and power among interest groups in an industry. In 1990, although the estimated producer surplus loss dwarfed that of exporters, the power function measure for exporters was nearly 500 times the producers' measure. The varying magnitudes indicate the overwhelming incentives for exporters, vis-a-vis the producers, to overcome the free rider constraint to collective action. In fact, the only formal interest groups in the robusta sector are the GEX, which was organized in 1991 after the losses incurred in 1989 and 1990, and an association of coffee hullers. The relationships between the power functions strongly suggest that the exporters will be the most likely to achieve lobbying success in favorably influencing the determination of the *bareme*. Empirically this was observed in 1991 and 1992 when exporters witnessed a partial reversal of the losses incurred in 1989 and 1990. Given the low level of optimal lobbying expenditures, the endogenous formation of a formal producer coalition or interest group is not likely. A major implication is that the political influence of these groups must be borne in mind when predictions are made of the likely distribution from the recent doubling of the CIF border price following the devaluation.

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[12] The multiplicative constant for the producer supply of coffee was solved by assuming the average output from 1984 to 1987 of 111,300 metric tons and the short-run supply elasticity estimate.

Table 4.7. Change in Surplus and Power Function Estimates of Optimal Lobby Contributions, Cameroon Robusta Coffee Sector, 1988-92.

Year	Producers		Exporters	
	surplus gain (loss) -------(000 FCFA)--------	power function	surplus gain (loss) -------(000 FCFA)--------	power function
1989	-1,440,686	8.47	-4,165,726	245,042
1990	-23,535,158	138.44	-1,164,817	68,518
1991	-1,370,567	8.06	774,577	45,563
1992			905,921	53,289
1993	-3,458,450	20.34	n.a.	n.a.

This analysis has not addressed issues dealing with the supply of political influence within the presidency nor the important role that ideology may play in the policy formation process (see Van de Walle, 1988). It does, however, illustrate the market structure forces that have resulted in the negligible political voice of coffee farmers in Cameroon, namely, large numbers of small producers with a relatively inelastic supply response.

The power function analysis has highlighted the influence that a concentrated exporter group may have on the determination of prices in the sector. In the following section, the influence on producer prices of the recent movement of Cameroon society towards more democratic institutions are examined.

The Influence of Democratic Reforms on the Level of Producer Price

Kenya presents an interesting contrast to Cameroonian small holder policy. Kenyan small holders have received a much higher percentage of border prices for their export commodities (Lele and Agrawal, 1989). This result has been attributed to the demand at independence by these

producers that they be given the same consideration as the politically influential estate sector. Furthermore, the ruling elite in Kenya, which coopted power following the Mau rebellion, had considerable interests in the cash crop sector and, in contrast to so many political parties at the time, sought policies leading to accumulation rather than redistribution of wealth (Bates, 1989). In Cameroon, the estate sector in the coffee industry was able to obtain the right to export its coffee without regard to the *bareme*, but smallholders did not similarly benefit.[13] The explanation of this dichotomous policy regime has some of the flavor of the interest group analysis of the *bareme* above. Explanation is also found in the much smaller importance and visibility of the estate sector in Cameroon. In contrast to the large British settler population in Kenya, there was never a large colonial settler class in the rural areas of Cameroon to foster the political consciousness of the small-holder.

Evidence of a change in the political equilibrium of Cameroonian society was recently manifested in the first ever multi-party presidential elections held in late 1992. The re-elected incumbent, Paul Biya, garnered the political support of cocoa growers in his home area of the South and Center Provinces by maintaining official cocoa prices at 200 FCFA per kilogram, whereas the coffee growers of the West and Littoral Provinces, who in the main supported the populist opposition candidacy of John Fru Ndi, saw a decline in producer price both prior to and following

[13] The estate sector in the arabica sector consists of approximately 25-30 coffee plantations in the West Province who prior to independence had organized a marketing cooperative COOPAGRO; in the robusta sector there is only the aforementioned CFSO in the East Province.

the election.[14] The relatively higher price for cocoa was a key factor in Biya's narrow margin (< 2 percent) of victory. In explaining agricultural protection, Lindbeck (1988) argues that sudden drops in income motivate farmers to seek political protection. Certainly, the income loss experienced by producers from the fall in official producer prices was, and will continue to be, a significant factor in mobilizing rural political support, assuming the continuation of democratic reforms.

This change in political institutions (from a single party to a multi-party system) has invested more political power in the peasantry than was previously the case. Prior to the move towards a multi-party system, Ntangsi (1987, p. 42) wrote

> . . . the Cameroon peasantry are not directly represented in the political system, do not possess formal political power and therefore do not directly influence policy-making.

While their political influence is still slight vis-a-vis urban-based groups, continued movement towards a democratic system of governance is likely to enhance this influence, since 50-60 percent of the population remains rural.

In summary, the heavy taxation through monopsonistic pricing of small holder producers of coffee in Cameroon may be seen as the result of a demand for governmental revenues, an inelastic supply in the short-run, and a lack of alternative tax systems for the rural sector with comparable costs of collection. Because of large numbers, the incentives among

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[14] It is interesting to note the changes in producer prices of coffee and cocoa since opposition parties were allowed to form in 1990. Cocoa was cut from 420 to 250 FCFA in 1990 to 200 FCFA in 1991 were it has remained despite ever lower world prices. Robusta coffee went from 440 to 175 in 1990, to 155 in 1991 and 1992, to 100 FCFA in 1993.

producers to seek political protection are considerably weakened due to the free rider problem.

Implications of the analysis for the recent upswing in the border price (due to the devaluation, a Brazilian freeze, and drought in Latin America) indicate that producers should not expect a complete price pass through for several reasons. First, are the economic arguments for less than a complete pass through, i.e., positively sloped supply functions for hullers and exporters. More importantly perhaps is the appetite exhibited historically by developing country governments for the quasi-rents generated periodically in the tropical beverage sector. Although it appears that the arabica sector is on the road to reform, the state apparatus for taxation of the more important robusta sector is still in place. Finally liberalization, which results in the replacement of a public monopoly by a highly concentrated private sector, may result in little change in pricing patterns at the producer level. However, recent reductions in the size of government, the continuation of democratic reforms, coupled with the devaluation and Brazilian freeze promise a more positive portend for small holder coffee producers of Cameroon.

CHAPTER 5
SUMMARY AND CONCLUSIONS

A farm-level vintage production coffee supply model was developed using panel data on new plantings, replantings, annual output, and fertilizer usage. Though there exist broad methodological differences, it is interesting to compare the mean parameter estimates from this study's results with previous empirical works which have estimated aggregate representative agent models of supply.

Examining the results from the short-run supply function, the estimated robusta elasticities with respect to current real producer price and real producer price lagged one period were .200, and .150, respectively. In the arabica sector, the elasticity of output to current real producer price was .429, while lagged price was not significantly different from zero. By varying the price component of expected gross revenues, arc own-price elasticity estimates of supply were obtained for varying lengths of run; supply elasticities after 5 years were .533 and .468 in the robusta and arabica sectors, respectively, and were .856 and .629 after 10 years. Similarly, by varying the yield component of expected gross revenues, the elasticities of supply with respect to a yield innovation were calculated after 10 years as 1.01 and .344 in the robusta and arabica sectors, respectively. In contrast to other studies, which typically substitute proxy functions of lagged prices for perennial crop revenue expectations, the incorporation of the age-yield profile into

the producer's gross revenue forecast was the innovation which allowed the derivation of these yield elasticities.

Examining the producer investment relationships underlying the long-run supply response, the robusta mean elasticity of new plantings with respect to a change in expected gross revenues was 3.04, while the mean elasticity of replanting was .512. In the arabica sector, the new planting mean elasticity was 1.58 and the replanting mean elasticity was .601.

The majority of studies examining the price responsiveness of perennial crops have made use of the Nerlovian supply model and generally estimate both a short-run and a long-run supply elasticity. The means of short-run and long-run price elasticities were .275 and .536 for ten coffee studies summarized in Askari and Cummings' (1978) extensive review of empirical Nerlovian agricultural supply literature. The relatively high coefficients of variation, (.808 for the short-run, and .394 for the long-run), indicate a significant amount of cross-country variation in these estimates. For the subset of African coffee producers, mean elasticities were .277 and .462 in the short- and long-run, respectively.

A comparison of the elasticities of the mean producer of this study and those of the Nerlovian specifications does not show a great deal of divergence especially in the short-run, indicating a complementary role for the two approaches in the study of perennial supply response. In the long-run, more of a divergence was noted, although this study's estimates still fall within the upper range of the Nerlovian specifications. Nerlovian assumptions regarding the biological relationship do not permit a comparison with the estimated yield innovations elasticities.

A shortcoming of the Nerlovian models lies in their failure to distinguish between investment decisions concerning the tree stock and the short-run harvesting decision. The effects of changes in the composition of the tree stock age distribution due to producer investment behavior can not be disentangled from the short-run supply response given a fixed stock of trees. More recently, studies of perennial crops, this one included, have tended to focus on estimation of the underlying producer investment behavior and short-run supply function with an explicit accounting of the vintage nature of production. However, these models have been applied sparingly to the estimation of coffee response at the aggregate level because of persistent data limitations.

Akiyama (1988) attempted to estimate the structural relationships using a vintage technology approach for robusta coffee in Côte d'Ivoire. The results for aggregate new plantings and short-run supply response were not robust; most of his estimates were reported as not significantly different from zero. A major advantage of a micro-econometric approach is revealed in the comparison with the model of Akiyama. Because of limited time series data his parameter estimates were not precisely estimated; in contrast, the numerous degrees of freedom in this study improved the efficiency of the econometric estimates.The micro-econometric response estimates for expected revenues and price were nearly always significant.

In summary, the mean results establish the positive price responsiveness of the Cameroonian coffee producers, at magnitudes in general agreement with previous empirical work at the aggregate level. Moving beyond the discussion of the mean producer, one of the main focuses of this study has been the analysis of the underlying heterogeneity in the

supply response of the coffee sector in order to permit better informed policy decisions. The "representative agent" approach in aggregate studies of supply result in elasticity estimates that, while useful for certain policy purposes, cannot indicate strategies to affect the responsiveness of a sector. In contrast, a micro-econometric analysis permits the evaluation of the behavioral, motivational, and agro-ecological factors which cause the price responsiveness between farms and regions to differ.

Heterogeneous Producer Response

A common criticism of aggregate studies lies in their inability to distinguish the role of price incentives from other contextual factors (Rao, 1989). In this study, factors hypothesized as affecting the heterogeneity of supply response among farms included species of coffee, farm size, level of purchased inputs, regional effects due to variations in soil fertility and infrastructural and institutional development, farm size, age, and human capital investment.

Examining first the new planting component of supply response, an increasing age of the producer had a negative effect on the level of new plantings in both sectors. Given their mean age structure, the robusta producers of the West Province were more responsive in their new plantings, *ceteris paribus*. Although the effect of aging coffee producers in the declining fortunes of the coffee industry gets frequent mention in the popular press, this analysis delineates more precisely the nature of the effect. The inclusion of producer age did not have a significant effect on replanting or short-run supply levels, indicating for the latter that the age of the producer probably has little effect on the overall

quality of the labor input. The negative relation between producer age and new planting levels may be reflecting a subjective discount rate that increases with age. Information on the age of producers might be used to target dissemination efforts of improved varieties.

The importance of factor proportions at the micro-level on supply responsiveness was also evident. In the robusta sector, labor is relatively more scarce than in the arabica sector and, as a consequence, increasing family size had a positive effect on the level of new planting. At the provincial level, the sample mean of family size was largest in the Southwest Province. In both sectors, increasing fertilizer applications had a negative effect on the level of new planting indicating the land-substituting character of this input. The effect was more pronounced in the arabica sector, where the land constraint is greater. The land constraint facing new arabica plantings appears to be more severe in the West Province, where rural population pressures are highest. This observation was supported by a significant and positive effect on new plantings for the Northwest Province dummy variable.

The level of capital was positively related to the level of new plantings in the arabica sector. This result corresponds, to the extent that the capital stock of a farm is likely to be highly correlated with farm income, with the cross-country results of Askari and Cummings (1977), who found a similar positive effect for average farm income when regressed on cross-country supply elasticities.

In contrast to the new planting response, observed levels of replanting and short-run supply were found in both sectors to vary

positively with the rate of fertilizer application. The fertilizer demand was shown to vary positively with the amount of capital and farm size. The implication is that a well functioning fertilizer sector will increase the supply responsiveness of producers, especially as new plantings become constrained by available land.

Fertilizer demand among coffee farmers was responsive to prices, both own-price and the price of coffee. The absolute magnitudes of fertilizer and coffee price effects were roughly equal within each sector; across sectors, fertilizer demand was more elastic in the robusta sector. An issue commonly raised with a currency devaluation is the negative price effect on the demand for traded inputs such as fertilizer. However, in the case of coffee the negative effect is offset by the positive demand effect of an increased output price. The empirical results obtained indicate that the recent 50 percent devaluation in January 1994 should have relatively little effect on the quantities of fertilizer demanded by coffee farmers. However, a significant increase in fertilizer demand can be expected if world coffee price increases, from the ongoing drought in Latin America and the Brazilian freeze in June, 1994, are passed through to producers.

The level of education, measured as the number of years of schooling, had a significant positive effect in the robusta sector on short-run supply levels. A similar effect was not found in the arabica sector. The much smaller scale of the arabica coffee enterprise is noted as a possible explanation for the positive though nonsignificant education effect (the output of the average robusta producer was nearly 5 times that of the average arabica producer).

There were also significant regional differences in short-run supply. In the robusta sector, Littoral Province coffee farmers were more productive than West Province producers, who in turn were more productive than their Southwest counterparts; while in the arabica sector, Northwest Province arabica farmers were more productive than those in the West. Fertilizer demand was also significantly lower among Southwest Province robusta coffee farmers perhaps due to their more remote location.

As already discussed, the mean producer in the arabica sector was more price responsive in the short-run than the mean robusta producer, but was surpassed in the long-run. The explanation for the short-run divergence appears to be tied to higher levels of rural infrastructure in the arabica sector. A high level of infrastructure has engendered better communications and a greater scope of commercial activities, resulting in a wider set of opportunities for income generation outside the coffee sector. The reversal of results in the long-run is tied to the relatively greater existence of surplus lands in robusta growing areas which results in more price elastic new plantings. With a scarcity of good land for new coffee planting, future production increases in the arabica sector will be more dependent on yield improving technical innovations and replantings of uneconomic tree stocks. In the robusta sector, there is greater scope for production increases from area expansion.

In mature perennial crop industries, replantings are typically a more important determinant of long-run supply response (Hartley, Nerlove and Peters, 1987). This observation was confirmed in this study by arabica producers who demonstrated a greater responsiveness of replantings to expected revenues.

The cross-price elasticity for an index of alternative cash crops to coffee was significant and with greater effect in the robusta sector (-.36 versus -.11 and non-significant in the arabica sector). This index consisted of mainly food crops in the arabica sector and other tree crops such as plantains, oil palm and cocoa in the robusta sector. Many annual crop supply response studies have failed to find a significant response to the prices of alternative crops, which is generally attributed to the diffuse nature of the alternatives. A similar cause may be affecting these results, as a wider scope of alternative cash crops was indicated in the arabica sector vis-a-vis the robusta.

Research Recommendations

Further research is called for in the analysis and development of output simulation models for a broader range of farm categories using the parameter estimates and sample distribution. As seen, the supply response depends in part on the existing age distribution of trees. Given cross-farm variation in the age distribution and tree planting investment behavior, simulated output responses would vary as well. Simulation models could also be developed along other dimensions of interest such as age, family size or regional models. These models would provide more precise information on the responsiveness of the sector.

As regards the empirical methodology, the results of the robusta model were generally more robust than those of the arabica sector. This is mainly attributable to the problems encountered in the estimation of the age-yield profile for arabica coffee. A search for discarded cooperative records in the arabica sector in order to more precisely estimate the age-yield profile would increase the efficiency of the

estimates and reduce a simultaneity bias that occurred from using the sample observations to construct the age-yield profile. The efficiency of the estimates would also be increased by simultaneous estimation of the producer's behavioral responses, especially the short-run supply and fertilizer demand. Unfortunately the complexity of full-information estimation methods for panel data with corner solutions has limited its use.

Evidence was presented that indicated a strong propensity to tax the production of coffee through the systematic suppression of producer price below border prices. The supply of these revenues was addressed in the development of the Brock-Magee power function model of interest groups. A fruitful extension of that analysis would be to include optimal taxation arguments that address the demand for government revenues.

A wider and more in-depth analysis of the impact of the recent reforms on the structure, conduct and performance of export marketing is needed. Efforts to examine changes in the marketing sector were hindered by political unrest and the contemporaneous nature of the reforms. Previous work has documented the high transaction costs facing arabica coffee producers in the arabica sector of the West Province prior to the market liberalization in 1993 (Langham and Ayissi, 1991). The degree, to which the liberalization has reduced these costs, would be very useful information for maintaining political support for the reforms.

Policy Considerations

Broad-based equitable economic growth is an important, but elusive objective for many developing countries. Cameroon has been one of only a few African nations to have experienced such growth following its

independence. From 1960 to 1977, an important component of annual GDP growth of 3.0 percent was a rapid growth in coffee exports from a predominantly small holder production base. GDP growth accelerated when oil was discovered in the late 1970s, as oil royalties accruing to the state begot a swift increase in the public sector and the non-traded goods sector serving the construction and service needs of this sector.[1] Export agriculture, in the course of a few years in the late 1970s, was succeeded by bureaucratic government as the leading growth sector in the economy. A Cameroonian version of the "Dutch Disease" resulted in a steady deterioration of producer incentives, mainly through a worsening of the internal terms of trade. Annual growth in coffee exports declined from 5 percent in the post-independence, pre-oil discovery period to an insignificant 0.4 percent from 1978 to 1993.

With a rapid decline in its terms of trade in 1986 and declining oil production, the Cameroon economy regressed significantly after nearly 30 years of uninterrupted economic growth. From 1987 to 1992, real GDP declined at an annual rate of 4.5 percent, while at the same time annual population growth was estimated at 2.9 percent. Given the limited remaining oil reserves, the ability of export agriculture to once again assume a leading role in the economic growth of the country is at issue.[2] An important question is whether the recent downward trend of the coffee

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[1] In 1984 the public sector accounted for 28 percent of the total employees in the formal sector, not including those employed in parastatal enterprises (EIU, 1993).

[2] Oil production in 1992 was 33 percent less than the production peak attained in 1985. The identified remaining reserves in 1992 will be depleted by the year 2000 if extraction continues at the 1992 rate. Even in the face of declining production, approximately 1/3 of government revenues were from oil royalties in 1991 (EIU, 1993).

sector will continue, or whether government policies can redress the situation and reestablish the coffee sector as a dynamic growth sector in the development of the nation.

The answer will depend on the responsiveness of the sector to the policy instruments at the control of the government. Evidence of past monopsonistic pricing policies has been revealed in both sectors. Now, with the dismantling of the ONCPB, which was the chief instrument of the monopsonistic pricing norm, and increasing liberalization of marketing, the responsiveness of producers to price incentives has become a major issue. The analysis has provided ample evidence that increasing producer prices will increase exports, foreign exchange earnings and rural incomes significantly. Pricing and market reforms are a necessary and crucial element in redressing the stagnation of the coffee sector, however, more is required.

Although the profitability of the Cameroon coffee sector has recently improved due to the devaluation and quasi-rents emanating from the Brazilian freeze and drought, to recapture robusta market share lost to South East Asian producers in the 1980s, costs of production and marketing must be lowered. To lower these costs will require both public and private sector action.

Cameroon producers, with an average yield from 1970-88 of 371 kilograms per hectare, appear to be less productive than Indonesian suppliers of robusta coffee with average yields of 574 kilograms over the same period.[3] This yield gap is not an insurmountable obstacle,

[3] Indonesia has grown to be largest producer of robusta coffee in a relatively short period of time. This has been accomplished by a combination of price policy reforms and investment in rural

especially given the near unanimous non-adoption of high yielding clonal varieties. To improve yields will require a multi-dimensional approach with an emphasis on applied agronomic research, effective extension of research results, and infrastructural investments.

Agronomic research and extension efforts need to be guided by ex ante appraisal of the returns to the gamut of possible research and extension activities. Towards that end, the model simulations reported in this study indicate that a yield increase would have a higher shadow value in the robusta sector than in the arabica sector, (i.e., result in a greater reduction in the costs of production). The implication of this observation for directing research, however, is tempered by acknowledgement of the recent widening of the price gap between washed arabica and robusta coffees on world markets.[4] Arabica's price premium is projected to decline to 25-35 percent in the near-term if an increase in robusta demand in Eastern Europe materializes (World Bank, 1992).

Socio-economic research into the adoption process for high yielding clonal varieties should be high on the list of research priorities for the Cameroon coffee sector. Identification of the resource constraints facing producers would permit the design of technology packages with higher adoption probabilities. The exhibited success of the Training and Visit system of extension should be considered as a means of disseminating information on existing improved clonal materials in the robusta sector.

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infrastructure. The Indonesian total of nominal direct and indirect rates of producer taxation which averaged 40 percent from 1976 to 1980, fell to 5 percent from 1981 to 1985; in contrast Cameroon producers were taxed an average of 55 percent from 1981 to 1985 (Gorn, Herrmann, and Schalk, 1993).

[4] The price premium for Cameroonian washed arabica over robusta was 25 percent in 1988 and 52 percent in 1991.

In the arabica sector, existing varietal innovations do not seem to offer the same magnitude of yield advantages as they do in the robusta sector. Efforts to adapt high yielding Caturra varieties from Latin America have been hampered by the low resistance of these varieties to coffee berry disease. Since the late 1970s, the cooperatives have been making a "Java" variety of coffee available. The yield gains of this variety are dependent on high chemical input levels, in a monoculture system. Although a significant portion of coffee trees planted were this variety (20 percent), there was no discernable effect on output in the regression analysis. This non-response appears to be mainly due to a failure to adopt the necessary cultural practices, specifically, continued intercropping with low levels of fertilization, both of which were induced by low price incentives.

Improved profitability also requires a lowering of the marketing costs, of both inputs and output. Marketing costs in Cameroon are approximately double those of Indonesia (Freud and Hanak-Freud, 1994). Strategies for lowering marketing costs include further deregulation of panterritorial pricing in the robusta sector, greater encouragement of marketing competition, a change in producer purchasing by the hulling mills from dehulled robusta coffee to dried cherries, improvement of the rural feeder road network, and completion of the Dschang-Melong trunk route.[5]

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[5] Currently coffee produced in Menoua division which is the largest producer of arabica coffee must be routed through Bafoussam in order to reach Douala. Completion of this road would result in a time savings of over 3 hours.

A well developed infrastructure is crucial to lowering marketing costs. Declines in rural infrastructure investments previously undertaken by the cooperatives from monopsonistic surpluses are a likely effect of the liberalization of arabica markets in the West Province, unless alternative funding can be devised. A producer checkoff payment earmarked specifically for rural investment and maintenance projects might be a politically viable alternative for local governments to undertake. For example, producers living along the Melong-Bangam road in the Moungo and Meme Divisions might be willing to fund its improvement if they were to individually benefit.[6]

The analysis of lobbying influences on the setting of the *bareme* in the robusta sector placed emphasis on the concentrated nature of the export sector. The high level of concentration in this sector and the arabica sector, where marketing has been dominated by a few cooperatives raises a caution--enhanced economic efficiency may not result if the market power of the exporters is exerted. Marketing agents in many parts of the developing world have developed a bad reputation because of allegedly excessive marketing margins. Marketing research focusing on the estimation of marketing costs and margins is needed in order to objectively evaluate market performance. An anti-trust role for government exists to ensure that excess profits do not accrue to the marketing sector.

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[6]This road connects Melong on the Douala trunk road with Bangem located on the slopes of the volcanic Manengouba some 43 kilometers in distance. The road, in miserable shape in the dry season, is only passable by all terrain vehicles in the rainy season and requires 6 plus hours to traverse, which is more than 3 times the dry season time expenditure.

Conclusions

The analysis of coffee supply response based on a random survey of 500 coffee producers in the major producing provinces of Cameroon has yielded insights into producer supply response that an aggregate approach is unable to provide. The fixed effects Tobit models permitted analysis of a range of factors affecting individual producer response. The value of the information garnered from the models in fine tuning policy decision-making is high. The benefits of the approach, however, must be weighed against the costs of conducting this type of analysis, which were also high.

In general, the growth in both the arabica and robusta coffee sectors has been mainly the result of land expansion rather than increasing land yields. The overall supply response to price factors was significant, as small holder producers of coffee in Cameroon were shown to be responsive to expected revenue and price signals in their tree stock investment, fertilizer use and short-run supply response behavior. The liberalization of coffee marketing, to the extent that it results in higher incentives to producers, will have a positive, but heterogeneous effect, with a greater response expected from the robusta sector *ceteris paribus*.

The analysis of supply response highlighted the effect of expected gross revenues, i.e., discounted expected price times expected yields, on producer behavior. Government efforts have focused most of their recent attention on price policy reform, a considerably smaller effort has been undertaken in developing the other crucial component of gross revenues, i.e., expected yields. Continued long-run broad-based growth in the

coffee sector, after the "getting prices right" growth spurt has played out, will require technical innovations to lower production costs and increased rural investments to lower marketing costs. Both of these areas require government leadership.

APPENDIX A
SURVEY METHODOLOGY

In August and September of 1992, the Department of Agricultural Economics at the University of Dschang conducted a survey of 500 coffee producers with financial support from the Fertilizer Sub-Sector Reform Program of USAID to examine the impact of fertilizer and price policy reforms in the coffee sector.

The survey sampled 250 producers in the arabica sector from the 8 premier divisions nationwide in terms of production tonnage from an estimated population of 110,871 coffee producers.[1] The divisions were Mezam, Bui, Mentchum and Donga Mantung in the Northwest Province and Menoua, Bamboutos, Mifi, and Noun in the West Province. Together the output of these divisions accounted for approximately 97 percent of the total produced by the Cameroonian arabica small-holder sector in the 1980s (MINAGRI/DEP).[2] A similar size sample was drawn in the robusta sector from an estimated population of 75,316 producers. Divisions covered by this survey were Moungo of the Littoral Province, Menoua, Haute Nkam, Nde, and Noun divisions of the West Province, and Manyu and Meme of the Southwest Province. The output of these divisions in the 1980s was

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[1]The division or *departément* is the next political division of government following the provincial level.

[2]The arabica sector is mainly characterized by small-holder production with the exception of a few large-scale planters (>50 hectares) affiliated with COOPAGRO in the Noun Division. Annual production by COOPAGRO normally accounts for between 1 to 3 percent of the national total.

approximately 80 percent of the national output over this period (MINAGRI/DEP). In the robusta area the major producing area not surveyed was the East Province, which produced annually between 3 and 10 percent of the total.

Given an emphasis on measuring the supply response of coffee, a stratified sample was drawn based on the criterion of mean kilograms of coffee produced per producer in each division. Sample sizes were determined from *a priori* knowledge of the study population (Table A.1) and the following formula for an efficient sampling design

$$n_h = n \frac{N_h S_h}{\sum N_h S_h} \qquad \text{(A.1)}$$

(Snedecor and Cochran, pp. 446-48). The sample size for the hth division was n_h, N_h was the population size, and n was the total sample drawn. S_h was the estimated production standard deviation of the average producer in division h.

The standard deviations were estimated using annual production data from 256 ONCPB farm production booklets for the Moungo division from 1984-1989. The annual variance of production was estimated for each of the 256 coffee farms. The standard deviations were then regressed on the mean level of production per coffee farm for the 256 coffee farms

$$\text{STD DEV} = 0.75954\ \text{MEAN} \qquad R^2 = .73$$

$$(0.021067)$$

where the standard error of the estimate is given in parentheses. This regression was then used to predict the variance of the average producer (i.e., average annual production per farm) for the 7 divisions in the robusta sector (Table A.1). Likewise, this regression was used to predict

the variance for the average producer in the arabica sector (assuming similar variability in annual production for these producers).

The sample size for each division is given in the last column of Table A.1. The weighting used by the Department of Agricultural Economics draws a relatively larger sample from those divisions with a greater mean production and standard deviation per producer, in contrast to a strictly proportional weighting based on the number of producers per division.

An English exemplar of the questionnaire used in the interviews can be found at the end of this appendix. Enumerators were hired from the divisional delegations of the Ministry of Agriculture according to several criteria with the aim of reducing measurement error. The first criterion was the selection of persons fluent in the locally spoken dialect (there are purportedly between two and three hundred dialects spoken in Cameroon). In the anglophone divisions of the Southwest and Northwest Provinces, most farmers and enumerators were fluent in pidgin English so that language did not present as great a problem in those areas. The second criterion was to attempt to recruit enumerators from among the recent graduates of the University of Dschang, whom the Department felt would show loyalty and pride in being associated with a research project conducted by their former professors from the Department of Rural Economics.

The selection of farmers interviewed was randomized at two different levels. In the case of the arabica sector, a list of cooperative centers or primary societies (the smallest administrative units of UCCAO and the NWCA) was made for each division. For robusta a list of the various localities and villages served by the extension service of MINAGRI was

Table A.1. Production Parameters of Arabica and Robusta Small Holder Sector and Sample Size, by Division.

Division	No. of Farmers	Mean Production per Farm, (kgs)	Std. Dev.	Mean Divisional Production (000 MT)	Sample Size n_h
Donga Mantug	6,898	177	126	1,145	13
Mentchum	6,613	180	168	1,454	18
Bui	20,927	89	83	2,281	25
Mezam	13,779	410	168	2,866	32
Menoua	20,698	240	171	4,657	52
Bamboutos	18,136	216	168	3,881	43
Mifi	17,241	180	145	3,293	37
Noun	6,613	309	328	2,857	32
Robusta Small Holder Sector by Division					
Moungo	17,479	1,988	1,510	34,748	129
Menoua	3,961	240	682	3,557	13
Haute Nkam	20,498	260	535	14,451	53
Nde	3,994	510	387	2,037	9
Noun	8,067	673	511	5,429	25
Meme	12,246	410	311	5,021	18
Manyu	9,071	278	211	2,522	9

Sources: Annuaire de Statistics Agricoles, various issues, MINAGRI/DEP; Direction Financiere et Comptable, UCCAO; MINAGRI/DEAPA, Agricultural Census and Surveys, 1984, 1986, 1987.

made. From these lists a sufficient number of villages, centers and societies were randomly chosen. The number was a function of the total number of to be interviewed in the division and the number to be interviewed from each village or cooperative center. To reduce the transportation costs of the enumerators, 2 to 4 farmers were interviewed in each of the selected locales. When a list of coffee farmers existed in

the village or cooperative center (generally the case for the cooperative centers and primary societies of the arabica sector) the producers were randomly selected from these lists.[3] If there was no list, the enumerators were instructed to create one by questioning the locals on the names of known coffee growers in the selected locale and then randomly selecting producers from that list. Thus, the design was not completely randomized because of the lack of a complete list of coffee farmers in the study area.

In the arabica sector, farmers are issued cooperative booklets, which record the annual production, fertilizer consumption and the dates the plantations were created. The production data in these booklets are relatively reliable because the cooperatives would in most years pay an end of season bonus once the coffee had been exported. This bonus was based on the recorded production in the farmer's booklet. A similar system of bonuses based on recorded production in a farmer's booklet (*Livret du Planteur*) was initiated in 1984 by the National Produce Marketing Board (ONCPB) for the robusta sector (an example is presented in Appendix C). These farm production records were requested of the farmers and the data within transcribed by the enumerators.

In addition to the survey data, a cache of farmer's ONCPB production booklets was discovered in the offices of the MINAGRI extension service in Moungo province. Permission was obtained to record the data and over 1,000 of these booklets were entered into a database. These data were extremely useful in establishing the age-yield profile for robusta coffee.

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[3] The use of cooperative lists in the sample design introduces a bias against the selection of women coffee farmers who have traditionally been denied access to the coffee cooperatives.

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UNIVERSITY CENTER OF DSCHANG
DEPARTMENT OF AGRICULTURAL ECONOMICS

PRICE POLICY ANALYSIS IN THE COFFEE SUBSECTOR OF CAMEROON

The main objective of this study is to understand how coffee farmers are responding to recent changes in the price of coffee, fertilizer and pesticides. The emphasis is on coffee production, but some information on other farm and non-farm activities will be collected.

THE DATA COLLECTED IN THIS QUESTIONNAIRE WILL BE TREATED ANONYMOUSLY TO INSURE THEIR CONFIDENTIALITY.

The respondents have been selected at random. We appreciate the kind collaboration of all the respondents.

ARABICA QUESTIONNAIRE

I. IDENTIFICATION AND GENERAL CHARACTERISTICS:

QUESTIONNAIRE NUMBER_____

1- Province_____ _____[001]

2- Division_____ _____[002]

3- Sub-division or district _____ _____[003]

4- Village _____ 5- Quarter_____

5- Name of the Cooperative_____ _____[004]

7- Name of the coop Section (Union)_____ _____[005]

8- Name of the coop Center (Society)_____ _____[006]

9- Name of the farmer[4]_____

10- Date of Birth of Farmer:_____ or Age_____ _____[007]

11- Sex of coffee farmer: MALE___1 FEMALE___0 _____[008]

12- Years of schooling -- farmer? _____[009]years.

---

[4] Farmer identification was not encoded in the data base created.

12a. What is the highest diploma or degree that you have obtained?

None..... ____0
CEPC..... ____1
Primary school certificate..... ____2
BEPC..... ____3
Ordinary level..... ____4
Baccalaureate..... ____5
Advanced level..... ____6
Other _____ ____7 _____[010]

13. In what year did you first begin growing coffee?

19_____ _____[011]

II. FARM.

1. Please tell us about your ARABICA coffee farm and the crops interplanted with coffee described as follows:

FIELD NO.	AVERAGE SPACING (METER)	NO. OF TREES	CROPS INTERPLANTED:Y=YAMS G=GROUNDNUT P=POTATO B=BEAN PI=PINEAPPLE M=MAIZE CT=COCOYAMS/TARO BaP=BANANA/PLANTAIN
i.			Y G P B PI M CT BaP NONE OTHER_____
ii.			Y G P B PI M CT BaP NONE OTHER_____
iii.			Y G P B PI M CT BaP NONE OTHER_____
iv.			Y G P B PI M CT BaP NONE OTHER_____
v.			Y G P B PI M CT BaP NONE OTHER_____

_____[100]

Comments:

1a. Are your trees grown under shade trees?
Yes ___1 No ___0 _____[101]

2. Do you or your wives have any fields or land that have not been cropped for at least the last TWO YEARS? (Does the farmer have land that is fallow?)

Y____1 N____0 _____[102]

3. Please rank for us the FOUR most important CROP OR LIVESTOCK enterprises (including coffee) in terms of their net cash income in a normal year (example: 1st-coffee 2nd-maize 3rd-Irish potato 4th-chickens)

POSITION IN TERMS OF NET REVENUE	CROP/LIVESTOCK	
1st		_____[103]
2nd		_____[104]
3rd		_____[105]
4th		_____[106]

4. What type of title to your land do you have?

Customary tenure..... ___1
Official land certificate..... ___2
Lease agreement..... ___3
Other_____ ___4 _____[107]

5. Do you raise chickens on a commercial enterprise?

YES ____1 NO _____0 _____[108]

5a. If yes how many do you currently have on your farm?

_____[109] CHICKENS

6. How many pigs do you have on your farm at the current time?

_____[110] PIGS

7. Can you estimate the total number of hectares of your farm including the coffee fields and food crop fields?

_____[111] hectares

III. HISTORY OF COFFEE PRODUCTION AND SALES

1. Coffee Production by Years. As one of the primary objectives of this research is to measure how farmers have reacted in terms of the quantities of coffee produced as prices have changed over the years we would greatly appreciate access to your historical production records as recorded in your carnet de planteur. The use of this information is for strictly academic purposes and will not be used for any purpose except the research of price response of coffee farmers.

ONLY INFORMATION ON YOUR PRODUCTION IS DESIRED, WE WILL NOT RECORD ANY INFORMATION AS TO SALES FROM YOUR BOOKLET

(Record from farmer's book, please make sure that you record from all the farmer's books as there may be more than one):

	PARCHMENT			CHERRY			
YEAR	BAGS	KILOGRAMS	GOOD GRAIN (%)	BAGS	KILOGRAMS	GOOD GRAIN (%)	
91-92							[200]
90-91							[201]
89-90							[202]
88-89							[203]
87-88							[204]
86-87							[205]
85-86							[206]
84-85							[207]
83-84							[208]
82-83							[209]
81-82							[210]
80-81							[211]
79-80							[212]
78-79							[213]
77-78							[214]

2. Distance you must transport coffee to sell?

_____[215]km.

3. Cost of transportation per bag of coffee? _____[216]FCFA

4. Mode(s) of transportation used to sell coffee:

Taxicab.....	___1	Wheelbarrow.....	___6
Head transport..	___2	Bicycle.....	___7
Motorcycle.....	___3	Personal auto.....	___8
Pickup truck....	___4	None (sold on farm)..	___9
Pushcart.....	___5	Other_____	___10
			[217]

5. In 1991-92, did anyone besides the cooperative purchase the coffee you produced? Please include all buyers. (Mark 1 if a buyer, 0 if not)

Unauthorized buyer (coxeur). ___[218]
Another farmer..... ___[219]
Other_____ ___[220]

6. When did you receive the cash for your coffee in 1991-92 from each of the buyers listed in question 5 AND THE COOP?

	ON DELIVERY	AFTER DELIVERY	BEFORE DELIVERY	
		--no. of months--		
Coxeur				[221]
Farmer				[222]
Coop				[223]
Other				[224]

7. Have you ever in the past sold your coffee to another farmer or an unlicensed buyer (coxeur)?

Y___1 N___0. ____[225].

8. Are you still owed money from any previous coffee delivered to the coop?

YES ___1 NO ___0 _____[226]

8a. If yes, how much and since when?

_____FCFA _____DATE _____[227]

IV. AGE DISTRIBUTION OF TREES, NEW PLANTINGS, REPLANTINGS AND UPROOTINGS.

1. Please tell us about the NUMBER and TYPE of TREES you first planted and WHEN and any ADDITIONAL plantings that ENLARGED the field. (For var. circle Ca if Caturra, Jv if Java, Jm if Jamaicain, and U if unknown).

Field no.	1ST PLANTING			2ND PLANTING			3RD PLANTING		
	#trees	year	var.	#trees	year	var.	#trees	year	var.
i.			Ca Jv Jm U			Ca Jv Jm U			Ca Jv Jm U
ii.			Ca Jv Jm U			Ca Jv Jm U			Ca Jv Jm U
iii.			Ca Jv Jm U			Ca Jv Jm U			Ca Jv Jm U
iv.			Ca Jv Jm U			Ca Jv Jm U			Ca Jv Jm U
v.			Ca Jv Jm U			Ca Jv Jm U			Ca Jv Jm U

1a. Where did you acquire these coffee trees? (Mark 1 if acquired from, 0 if not).

Cooperative..... ___[300]
Development authority..... ___[301]
Government services MINAGRI..... ___[302]
Market place..... ___[303]
Produced on farm..... ___[304]
Another farm..... ___[305]
Other_____ ___[306]

2. Since first planting these trees, have you replaced any of these original trees with new trees because of diseased or old trees or dead trees?

Y___1 N___0. _____[307]

(IF NO GO TO QUESTION 3).

2a. Please inform us as to how many trees on your plantation WERE REPLACED and with what variety for each of the last eight years if possible. (If no trees were replaced in a particular year mark 0; mark Jv if Java, Jm if Jamaicain, Ca if Caturra and U if variety is unknown.

YEAR	NO. OF REPLANTS	VAR.	YEAR	NO. OF REPLANTS	VAR.	YEAR	NO. OF REPLANTS	VAR.
92-93			89-90			86-87		
91-92			88-89			85-86		
90-91			87-88			84-85		

2b. What was the major reason that you replaced these trees? (Check only one response)

No longer productive due to old age....___1
Trees were dead or dying due to disease___2
New higher yielding variety available ___3
Subsidy paid to replant.....___4
Other_____ ___5 ____[308]

2c. Where did you acquire these coffee trees? (Mark 1 if acquired from, 0 if not).

Cooperative..... ___[309]
Development authority..... ___[310]
Government services MINAGRI..... ___[311]
Market place..... ___[312]
Produced on farm..... ___[313]
Another farm..... ___[314]
Other_____ ___[315]

2d. If purchased what was the price paid per seedling for the most recently purchased seedlings?

_____[316] fcfa/seedling

2e. Was a replanting subsidy ever paid to you by either the government or the cooperative for replanting your coffee (prime de regeneration)?

YES_____1 NO_____0 ____[317]. IF NO GO TO 3.

2f. If yes, please tell us in what year you received the subsidy, the amount of the subsidy and the number of trees, which you replanted because of the subsidy.

YEAR	SUBSIDY AMT.	NUMBER OF TREES	VARIETY
			Jm Jv Ca U
			Jm Jv Ca U

3. Since first planting your trees, have you removed (uprooted) any trees that have NOT BEEN REPLACED by new trees?

Y___1 N___0. ____[318]. If no, go to question 4.

3a. Please inform us as to when and how many of these original trees were removed (uprooted) for each of the last 4 years.

YEAR	NO. OF TREES UPROOTED
1992	
1991	
1990	
1989	

3b. What was the main reason that these trees were uprooted? (check only one response)

Low price of coffee..... ___ 1
Lack of an adequate labor supply..... ___ 2
Needed the field for food production..... ___ 3
Low productivity of trees..... ___ 4
Cost of fertilizer and pesticides..... ___ 5
Land used for alternative cash enterprise... ___ 6
_____ ___ 7

[319]

4. Do you have a nursery of coffee seedlings on your farm at the present time?

Yes ____1 No ____0 ____[320]. If no, go to section IV.

4a. If yes approximately how many seedlings do you currently have started?

_____[321] seedlings

5. Are you aware of the Java variety of arabica coffee?

Yes ____1 No ____0. _____[322]. If no go to section V: Coffee Inputs

6. How does the Java variety compare to the traditional variety in terms of yield?

Higher yields ____1
Lower yields ____2
No difference ____3 _____[323]

7. Is the Java variety in your opinion more or less resistant to attacks of anthracnose and other diseases as compared to the traditional variety?

Higher resistance ____1
Lower resistance ____2
No difference ____3 _____[324]

8. What are the other advantages and disadvantages of the Java variety?

ADVANTAGES:	DISADVANTAGES:

V. COFFEE INPUTS

A. FERTILIZER:

1. Do you normally use organic fertilizer or manure on your coffee?

Yes ___1 No ___0 ___[400]. If no go to Q2.

1a. If yes, what type of organic fertilizer or manure do you use?

Kitchen wastes.....____[401]
Pig manure.....____[402]
Chicken manure.....____[403]
Goat/sheep manure.....____[404]
Coffee pulp.....____[405]
Other_____ _____[406]

2. Have you in the past (prior to the fall in the price of coffee) normally used chemical fertilizer on your coffee?

Yes ___1 No ___0. ___[407]. If no, GO TO PART B, PESTICIDES, page 14.

3. History of Fertilizer Use (to be recorded from coffee book, or from recall of the farmer if not recorded). In the table below and if the records permit, indicate the amount of the fertilizer purchases used on coffee in parentheses. For example if 10 bags were purchased and 7 were used on coffee write 10,7 in the appropriate blank:

	QUANTITY OF FERTILIZER USED											
	20-10-10		AMM SUL		UREA		12-6-20		OTHER			PRIC
YEAR	SAC	KGS	SAC	KGS	SAC	KGS	SAC	KGS	TYPE	SAC	KGS	FCFA
92-93												
91-92												
90-91												
89-90												
88-89												
87-88												
86-87												
85-86												
84-85												
83-84												
82-83												
81-82												
80-81												
79-80												
78-79												
77-78												

3a. In general how do you usually purchase your fertilizer?

Operators equity (cash or cheque).....__1
Credit from coop.....__2
Loan from formal credit source.....__3
Loan from informal credit source (tontine)...__4
Other_____ __5 __[408]

4. Have you generally been able to purchase all the fertilizer you wanted to use ON YOUR COFFEE from your cooperative?

Yes____1 , No____0. _____[409]. If yes go to Q5.

4a. If no, briefly explain why not:

Quantity available for purchase
restricted by quantity of coffee sold ___1
Lack of sufficient funds..... ___2
Type of fertilizer desired
not available..>>.....___3
Lack of transportation.....___4
Too expensive.....___5
Other _____ ___6

[410]

5. In terms of the availability of fertilizer have you noticed any differences in the quantities available in the last few years since 1990?

More fertilizer available
from private sellers.....___1
Fewer shortages at coop.....___2
More shortages at cooperative.....___3
Wider variety of choice.....___4
No difference.....___5
Other_____ ___6 [411]

6. Given YOUR CHOICE and the CURRENT PRICE of fertilizer, what type or types of fertilizer do you prefer to apply to your coffee? (Mark 1 if preferred, 0 if not).

Ammonium Sulfate (21-0-0).. ___[412]
Urea (46-0-0)..... ___[413]
Composite (20-10-10)..... ___[414]
Composite (12-6-20)..... ___[415]
Other_____ ___[416]

7. Distance you must travel to buy fertilizer (km).

_____[417KM.

8. From whom did you receive fertilizer for your coffee in 1991-92? (Mark 1 if received from, 0 if not)

Coffee cooperative..... ___[418]
Development authority..... ___[419]
Government service(MINAGRI)..... ___[420]
Other farmers..... ___[421]
Private sellers in local market..... ___[422]
Retail store..... ___[423]
Authorized licensed coffee buyers..... ___[424]
Other _____ ___[425]

9. Mode(s) of transportation used to buy fertilizer:

Taxicab.....	___1	Personal automobile...	___5
Head transport	___2	Pushcart.....	___6
Motorcycle....	___3	Bicycle.....	___7
Pickup truck..	___4	Other_____	___8 ___[426]

10. What are your out-of-pocket expenses other than for the fertilizer when you go to buy fertilizer (for such things as travel and trucking expenses)?

_____[427]FCFA(average/trip).

B. INSECTICIDES and PESTICIDES.

1. Prior to the ending of the phytosanitary brigades in 1990, how often was your farm treated on average, in a typical year for anthracnose (*Collectotrichum coffeanum*) by these brigades?

_____[500]times annually

2. How many times did you treat your coffee with chemicals for anthracnose in:

1991-92? _____[501] TIMES 1992-93? _____[502] TIMES

3. Was your farm ever treated for Antestia (Antestiopsis spp.) by these brigades in the past?

Y___1 N___0 _____[503].

4. Did you treat for Antestia in:
1991-92? Yes ___1 No ___0 _____[504].
1992-93? Yes ___1 No ___0 _____[505].

5. History of pesticide use.

	INSECTICIDES				FUNGICIDES			
YEAR	TYPE	UNIT	QTY	PRICE	TYPE	UNIT	QTY	PRICE
92-93								
91-92								
90-91								
89-90								

WHAT WERE YOUR LEVELS OF USE PRIOR TO THE PRICE FALL IN 1989?								
88-89								

6. From Q5 if farmer purchased pesticides in either of the last two years: (If not go to Q7).

6a. Where did you receive or purchase the pesticides?

Coffee cooperative..... ___[506]
Development authority..... ___[507]
Government service(MINAGRI)..... ___[508]
Other farmers..... ___[509]
Private sellers in local market..... ___[510]
Retail store..... ___[511]
Authorized licensed coffee buyers..... ___[512]
Other _____ ___[513]

6b. Were you able to buy the TYPE and QUANTITY of PESTICIDE you desired WHEN you desired?
Yes___1 No___0. _____[514] If yes go to Q7.

6c. If no briefly explain why not:

Quantity available for purchase
restricted by quantity of coffee sold ___1
Lack of sufficient funds.....___2
Type of pesticide desired not available ___3
Lack of transportation.....___4
No access to sprayer.....___5
Other_____ ___6 ___[515]

7. Do you use herbicides for weed control?
YES ____1 NO ____0 _____[516]

C- EQUIPMENT/INFRASTRUCTURES/TOOLS

1. Which of the following equipment is owned by this household and in what quantity?

Chain saw.....____[601] Sprayer for pesticides...____[602]
Coffee pulper.....____[603] Pushcart.....____[604]
Cement drying floor....____[605] Secateurs.....____[606]
Thermo-nebulizer.....____[607] Cutlasses... .....____[608]
Axes.....____[609] Hoes.....____[610]
Fermenting vats.....____[611]

2. Do you or anyone in the household own? (Mark 1 if owned, 0 if not).
   Bicycle..... _____[612]
   Motorcycle..... _____[613]
   Automobile..... _____[614]
   Truck (lorry).... _____[615]

3. If you produce washed arabica coffee, how far do you have to travel from your home in meters to get water?
   _____[616] meters.

D. LABOR:

1. Would you please try to recall which of the following labor tasks were completed on WHAT PROPORTION of your mature coffee trees WHEN THE PRICE OF COFFEE WAS 475 FCFA PER KILOGRAM, and those which you completed in the last coffee season.

Circle N if NONE of the trees; S if SOME of the trees and A if ALL of the trees.

	LABOUR PRACTICES					
YEAR	PRUNING	FERT-ILIZED ONCE	FERT-ILIZED TWICE	1ST WEEDING	2ND WEEDING	3RD WEEDING
91-92	N S A	N S A	N S A	N S A	N S A	N S A
90-91	N S A	N S A	N S A	N S A	N S A	N S A
89-90	N S A	N S A	N S A	N S A	N S A	N S A
PRIOR TO THE PRICE FALL WHAT WERE YOUR NORMAL PRACTICES?						
88-89	N S A	N S A	N S A	N S A	N S A	N S A
87-88	N S A	N S A	N S A	N S A	N S A	N S A

2. Do you normally hire labor to help with your coffee production?
   Yes ____1, No ____0. _____[700].

   If YES go to 2a., if NO go to question 3 on page 18.
   2a. How do you pay the hired workers? (Enter 1 if used,0 if not)

   Wage rate per day..... _____[701] (If 1, go to 2b).
   Contract (piecework)... _____[702] (If 1, go to 2c).
   Salary per month..... _____[703] (If 1, go to 2d).

2b. Please try to recall to the best of your ability the WAGE RATE PAID PER DAY prior to the fall in the price of coffee and the wage rate currently being paid

	PRUNING	WEEDING	HARVESTING	FERTILIZING
YEAR	FCFA/DAY	FCFA/DAY	FCFA/DAY	FCFA/DAY
91-92				
90-91				
89-90				
PRIOR TO THE FALL IN COFFEE WHAT WERE THE RATES PAID?				
88-89				

2c. Please tell us, what were the terms of engagement for the contract labor used? (e.g., 500 FCFA/bag for harvesting, etc.)

		CONTRACT TERMS			
YEAR	FIELD NO.	PRUNING	WEEDING	HARVESTING	FERTILIZING
91-92	i.				
	ii.				
	iii.				
	iv.				
	v.				
WHAT WERE THE CONTRACT TERMS PRIOR TO THE FALL IN COFFEE?					
88-89	i.				
	ii.				
	iii.				
	iv.				
	v.				

2d. How many salaried workers have been employed since the price fall and how many were employed prior to the price fall?

YR	# workers	salary
91-92		
90-91		
89-90		
PRIOR TO THE FALL IN PRICE OF COFFEE		
88-89		

2e. Did you use any Nigerian workers on your coffee farm in 1991-92? Yes ____1 No ____0 _____[704]

3. HOUSEHOLD (FAMILY) LABOUR AVAILABILITY: Please tell us how the household farm labour supply has varied over the last 8 years due to deaths, new births, persons leaving the farm to work in a city, persons returning to farm after not finding work, etc. (Children living at home who are students should be counted as parttime labour)

	MALES > 16 YEARS		FEMALES >16 YEARS		CHILDREN 10-16	
YEAR	FULLTIME	PARTTIME	FULLTIME	PARTTIME	FULLTIME	PARTTIME
1992						
1991						
1990						
1989						
1988						
1987						
1986						
1985						
1984						
1983						

4. Do you depulp your own coffee? Y___1 N___0 ___[705].(If yes go to Q5).

4a. If no, what do you pay to have it depulped?
_____fcfa/_____. _____[706]

5. Did you do any work off your own farm for wages in 1991-92, or do you have an employable skill outside of your farm?

Y___1, N____0. _____[707]. If no go to next section.

5a. What is your other occupation?
_____[708]

5b. What was the average wage rate you received, or the usual fee charged for your services?
_____[709] .

5c. How many hours did you work on average during a typical work week at this job last year (1991-92)?
_____[710]hours/week on average.

V. Services of the Coffee Cooperative

1. During the past year how many times were you visited by an employee of the Coffee Cooperative who was seeing you in an official capacity?
_____[800] times.

2. Which of the following services have you or your community received from the Coffee Cooperative in addition to the services of buying coffee from you and selling fertilizer to you?

	Received in past	Received in 1992
Pesticide supply	___[801]	___[809]
Fungicide application.....	___[802]	___[810]
Village water supply.....	___[803]	___[811]
Road grading.....	___[804]	___[812]
Seedling supply.....	___[805]	___[813]
Extension advice.....	___[806]	___[814]
Financial credit.....	___[807]	___[815]
Other_____	___[808]	___[816]

3. Do you believe that the cooperative washing and drying of coffee could lead to farmers having a higher quality of coffee to sell?
YES ____1, NO ____0. _____[817]

Why? _____
_____
_____
_____

4. On a scale of ONE to TEN, with 10 the best possible score please rate your cooperative in terms of its overall performance and service to farmers like yourself.

1 2 3 4 5 6 7 8 9 10 _____ [818]

5. Are there any additional comments you would like to make concerning the state of the coffee industry in Cameroon?

_____

_____

_____

_____

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****

*

* END OF FORMAL INTERVIEW! THANK YOU FOR YOUR TIME. *

*

****

Names and signature of the interviewer.....

Names and signature of the controller.....

Date .....

APPENDIX B
LIVRET DU PLANTEUR

SOCIETE COOPERATIVE .....

LIVRET DU PLANTEUR

Nº 804171

OFFICE NATIONAL DE COMMERCIALISATION
DES PRODUITS DE BASE
(O.N.C.P.B.)

PLANTATION CAFEIERE ROBUSTA

Origine des Plants : tout venant

Type de plantation : Familiale [X] Industrielle [ ]

Date de création : 1960

Autres renseignements	84-85	85-86	86-87	87-88	88-89
Nombre total de pieds	2000				
(1) Jeunes					
(2) en production	2000				
Rendement					
Traitements phyto-sanitaires (Superficie)					
Antiscolyte	X				
Autres					
Superficie régénérée					
Engrais					
1er Epandage	X				
2me Epandage	X				
3me Epandage					
4me Epandage	---				

Le Responsable de l'Encadrement Agricole

COMMERCIALISATION DU CAFE ROBUSTA

LIBELLE	ANNEE				
	1984 - 1985	85 - 86	86 - 87	87 - 88	88 - 89
1ère Vente le	25-01-85	19/3/86	31/1/87	09/2/88	02/1/89
Coque (1)					
Supérieur	241	2728	1941	1778	2550
Courant					
Limite					
Ristourne (2)	7470	8160	58230	53160	72450
Valeur totale	144540	1278240	912270	777960	1274550
Signature PCVA — " — ONCPB				néant	
2me Vente le	30-3-85	8/4/86	18/2/87	08/2/88	24/1/89
Coque (1)					
Supérieur	1776	3743	2141	745	1270
Courant					
Limite					
Ristourne (2)	53280	117390	62330	21350	39650
Valeur totale	816960	1851240	992170		
Signature PCVA — " — ONCPB					
3me Vente le	27-4-85		24/03/87	25/03/88	05/4/89
Coque (1)					
Supérieur	1312		2540		
Courant				583	1042
Limite					
Ristourne (2)	39360		76200	17490	31685
Valeur totale	603520		1.193800	274010	577410
Signature PCVA — " — ONCPB					
RISTOURNE ANNUELLE					
REVENU ANNUEL					

(1) A ne remplir qu'en cas de vente en coque exceptionnellement autorisée
(2) Ristourne = Valeur (Tonnage supérieur + Tonnage courant) × Valeur ristourne

PAYE

COMMERCIALISATION DU CAFE ROBUSTA (SUITE)

LIBELLE	ANNEE				
	1984 - 1985	85 - 86	86 - 87	87 - 88	88 - 89
4me Vente le			2/4/87	13.00	13/6/89
Coque (1)					
Supérieur			290		325
Courant					
Limite					
Ristourne (2)			8.700		9.750
Valeur totale			136.300		152.750
Signature PCVA					
— " — ONCPB					
5me Vente le					
Coque (1)					
Supérieur					
Courant					
Limite					
Ristourne (2)					
Valeur totale					
Signature PCVA					
— " — ONCPB					
6me Vente le					
Coque (1)					
Supérieur					
Courant					
Limite					
Ristourne (2)					
Valeur totale					
Signature PCVA					
— " — ONCPB					
RISTOURNE ANNUELLE					
REVENU ANNUEL					

(1) A ne remplir qu'en cas de vente en coque exceptionnellement autorisée
(2) Ristourne par vente = (Tonnage supérieur + Tonnage courant) x Valeur ristourne

COMMERCIALISATION DU CAFE ROBUSTA (SUITE)

LIBELLE	ANNEE				
	1984 - 1985	85 - 86	86 - 87	87 - 88	88 - 89
7me Vente le					
Coque (1)					
Supérieur					
Courant					
Limite					
Ristourne (2)					
Valeur totale					
Signature PCVA					
— " — ONCPB					
8me Vente le					
Coque (1)					
Supérieur					
Courant					
Limite					
Ristourne (2)					
Valeur totale					
Signature PCVA					
— " — ONCPB					
9me Vente le					
Coque (1)					
Supérieur					
Courant					
Limite					
Ristourne (2)					
Valeur totale					
Signature PCVA					
— " — ONCPB					
RISTOURNE ANNUELLE					
REVENU ANNUEL					

(1) A ne remplir qu'en cas de vente en coque exceptionnellement autorisée
(2) Ristourne par vente = (Tonnage supérieur + Tonnage courant) × Valeur ristourne

COMMERCIALISATION DU CAFE ROBUSTA (SUITE ET FIN)

LIBELLE	ANNEE				
	1984 - 1985	85 - 86	86 - 87	87 - 88	88 - 89
10me Vente le					
Coque (1)					
Supérieur					
Courant					
Limite					
Ristourne (2)					
Valeur totale					
Signature PCVA					
— " — ONCPB					
11me Vente le					
Coque (1)					
Supérieur					
Courant					
Limite					
Ristourne (2)					
Valeur totale					
Signature PCVA					
— " — ONCPB					
12me Vente le					
Coque (1)					
Supérieur					
Courant					
Limite					
Ristourne (2)					
Valeur totale					
Signature PCVA					
— " — ONCPB					
RISTOURNE ANNUELLE			121.500		
REVENU ANNUEL					

(1) A ne remplir qu'en cas de vente en coque exceptionnellement autorisée
(2) Ristourne par vente = (Tonnage supérieur + Tonnage courant) x Valeur ristourne

APPENDIX C
OLS REGRESSION OUTPUT FOR SHORT-RUN SUPPLY

Table C.1. OLS Estimates of Short-run Supply Model for Both Arabica and Robusta, 1988-92.

Parameter	Arabica	Robusta
INTERCEPT	-0.1944	0.6372
$PCAFE_{it}$ real producer price	0.9176 (2.233)	0.2561 (0.9640)
$PCAFE_{it-1}$	-.4355 (-1.113)	0.3181 (1.743)
$QFEASIBLE_{it}$ feasible output	0.6630 (7.613)	0.9071 (15.94)
$PFERT_{it}$ real fertilizer price	0.0426 (0.224)	-.4010 (-1.943)
$POTHER_t$ real price of other cash crops	0.0066 (0.045)	-.7175 (-1.243)
Valid cases:	700	585
Dependent variable:	$QARAB_{it}$	$QROB_{it}$
Total SS:	2807.3	1042.3
Degrees of freedom:	694	579
R-squared:	.089	0.317
Rbar-squared:	.082	0.312
Residual SS:	2558.01	711.4
Std error of est:	1.920	1.108
F(5,694):	13.522	53.858
Probability of F:	0.000	0.000

Note: T-ratios are in parentheses.

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BIOGRAPHICAL SKETCH

James Jerome Gockowski was born to Marie and Jerome Gockowski on March 10, 1956, in Rochester, MN. He grew up in a Catholic household with five other siblings, living in Richfield, MN, Lincoln, NE, and Lanham, MD. After graduating from the University of Maryland's College of Agriculture with a B.S. in conservation and resource management, he joined the Peace Corps in 1980 and worked as an aquacultural extension agent in Zaïre, Central Africa. After returning to the States, he worked briefly as a counselor in a group home for retarded citizens and then enrolled in graduate school at the University of Tennessee in Knoxville. After obtaining his M.S. in agricultural economics in 1986, he accepted an assistant instructor position funded by USAID to teach agricultural economics at the University Center of Dschang, Cameroon, for two years. In 1989, he enrolled in the doctoral program in the Food and Resource Economics Department at the University of Florida.

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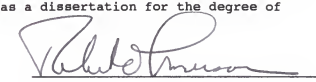

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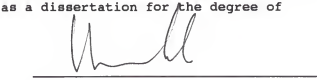

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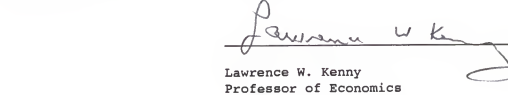

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